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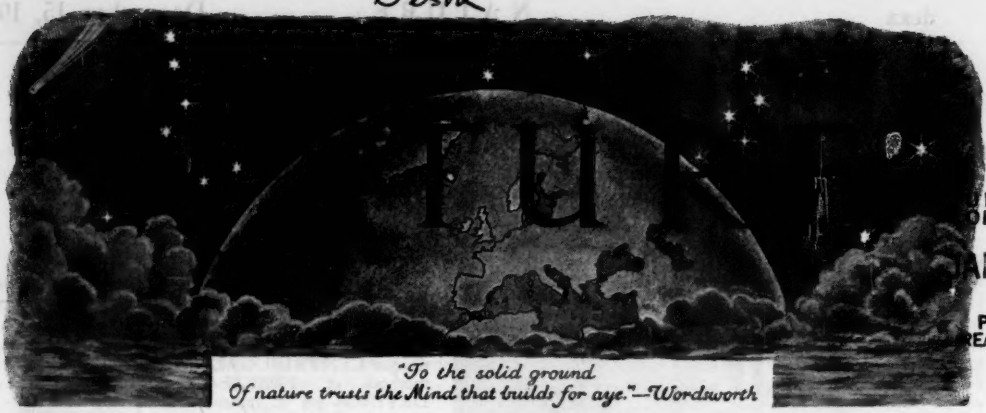

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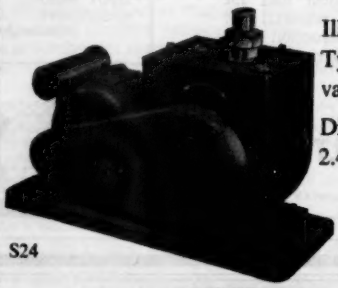

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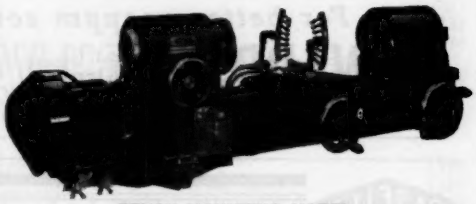

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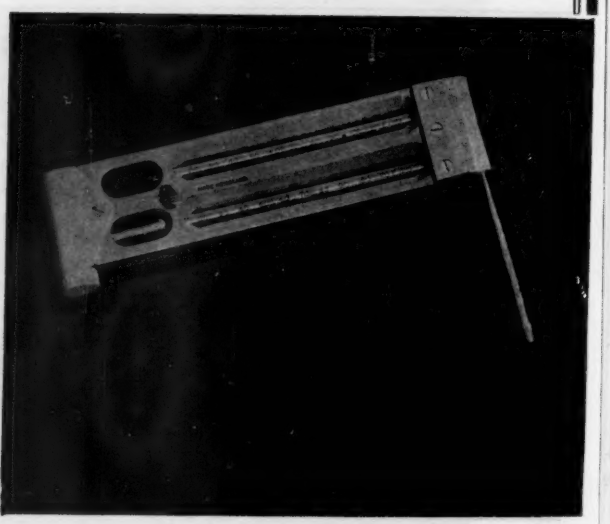

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NATURE

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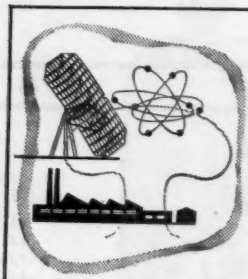

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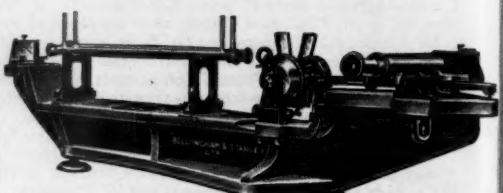

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LIBERAL EDUCATION IN TECHNICAL COLLEGES

THAT formal education in Great Britain must contain more science is now recognized as being necessary and inevitable by nearly all concerned with education. With the recognition goes the quite natural fear that in the process we shall lose some of those virtues which stem from studies based on the humanities. This has recently led to much discussion about ways in which science-based education can be liberalized, culminating in 1955 in the publication of a report prepared as a result of a nation-wide survey by the National Institute of Adult Education*.

The report attracted widespread attention and, in Yorkshire, it was decided to appoint a small working party composed of prominent industrialists and educationists who might give their views on the fundamental issues involved. These views have now been published as a pamphlet which deserves to reach a much wider audience than those members of the Yorkshire Council for Further Education for whom it was mainly intended†. Its true value is that those responsible for it are prominent in their respective fields, and yet came together not as strangers but fully aware of the difficulties confronting their colleagues in industry or education.

From the outset it was agreed that industry urgently needs men whose education is not narrowly restricted to technical matters and that the education given in technical colleges and at universities needs to be made broader and more liberal. While this view was unanimous, the report quickly and rightly describes the strong reaction among technical teachers at both colleges and universities against the tendency of many speakers and writers (usually persons trained in the humanities) to assert or assume that the technologist *ipso facto* is a philistine, who needs an injection of the humanities. The report goes further, and emphasizes that scientific education is a necessary part of cultural education.

Among a number of valuable points made in a section dealing with the teaching of science and technology in colleges is that the introduction of 'arts' subjects into curricula of science and technology is not fundamental to a liberal education. What is required is a broadening of the treatment and presentation of scientific and technological subjects. This ought to be adapted to the age and interests of the students. The approach may be through the history of the craft, a study of the structure of the industry, the philosophy of the subject, human relations in industry, or talks and discussions on industrial design. This approach to the teaching of science and technology could be greatly helped and stimulated by occasional talks by eminent personalities from science, technology and industry, capable of inspiring interest and promoting a further pursuit of this interest by the students themselves.

Ideally, all teachers of technical subjects should have an interest in the historical and philosophical aspects of their subject. Homework should be devised to develop the student's powers of expression, and if English or social history or current affairs is taught separately by a specialist, there should be the closest collaboration between this teacher and the technical specialist. To encourage a wide approach, it is recommended that in as many courses as possible 'liberal' reading should be included each session. To make this realistic, questions based on this 'liberal' reading should be set in college examinations.

Short residential courses for technical students, similar to those which have been held for management students, foremen and local government officers, but not necessarily confined to students in one subject, and dealing with the history and philosophy of science and other suitable topics, could also play an important part in developing the width of view commonly regarded as 'liberal'; this is already common practice in some parts of Britain. Many firms, for example, make considerable use of the general educational courses arranged in residential colleges as a means of 'broadening' their young employees.

It is easy to exaggerate the alleged narrowness of educational provision in British technical colleges. But there are many teachers with a width of outlook who teach their subjects supremely well, of colleges with vigorous music and drama departments, and student activities which compare favourably with those at some universities. Many full-time teachers and most part-time teachers have had no pedagogic training, but nearly all of them have earned, or at present earn, their livings in some job other than teaching, and bring their wide experience to enliven and improve their teaching.

Nevertheless, most teachers in further education are well aware that the techniques of teaching an ever-expanding and changing body of scientific and technical knowledge can always benefit from further study and discussion; it is encouraging that the Yorkshire Council for Further Education is shortly to organize a residential course for heads of departments which will be devoted to discussion of how technical subjects can be taught in a liberal manner. The place in all technical courses of the history and philosophy of science will also be dealt with.

The report recommends that more should be done to encourage travel by students, by making awards tenable at foreign institutions, and that international exchanges of technical teachers should be greatly extended. Much could be done by local education authorities by encouraging teachers to visit other institutions to study teaching methods and organization.

* Liberal Education in a Technical Age (Max Parrish).

† The Liberal Aspect of Technical Education. (Yorkshire Council for Further Education.) 2s. 6d.

The increasing domination of technical college syllabuses by examining and professional bodies is emphasized in the report. Fortunately, their officers often advocate more breadth and liberality of treatment. Extensions of scientific knowledge and new industrial processes, however, and the desire that nationally recognized qualification in one industry shall be as acceptable as that in other industries largely determine the views of industrial members of advisory and examining committees, and undoubtedly exert a narrowing influence. In what ways can this situation be remedied?

First, the examining and professional bodies themselves could embark upon a bold campaign of re-orientation of syllabuses and review their examination techniques. The City and Guilds of London Institute affords examples of what is already being done. These, if not yet extensive in achievement, point the way.

If some element of history, philosophy, art, economics or human relations is to be included in technical syllabuses, examination papers should include a section on this aspect of the course. If colleges are to be persuaded to make bold experiments in the teaching of science and technology, if attempts are to be made to encourage wider interests, better English, and an appreciation of human affairs and of moral and æsthetic values, these efforts must be encouraged by professional examining committees by treating them as integral to the whole scheme and included in the examination as such.

A considerable section of industry is well aware that many of its problems are human rather than technical, and would welcome the introduction of a broader approach to the teaching of science and technology.

On what lines could industry help to stimulate such a development? On many advisory committees of examining bodies, attempts to broaden syllabuses and examinations are not greeted with enthusiasm by some industrial representatives. Industrial organizations should see to it that their representatives on local, regional and national advisory committees, and the examiners whose names they put forward, are sympathetic to a really bold and fundamental attack on this problem. In many cases they might consider nominating persons who are near to the personal problems of the industry rather than purely technical officers.

A more immediate and practical step is to help in providing students for 'sandwich' courses and in granting day release where this is not already done. Firms, too, should be encouraged to send their young employees overseas to extend their experience; this is probably being done to a much greater extent than the committee realizes. The iron and steel industry, for example, has for many years sent large numbers of its younger technical men to steelworks in other countries simply to give them wider experience.

Local education authorities play a large part in the liberalization of technical studies. The part could be much bigger. How many technical colleges, for example, have libraries worthy of the name? Recent reports on this subject form depressing reading. How many colleges have adequate common rooms for students and staff? Refectories and facilities for social events are also essential. College surveys suggest that only a small percentage of students participate actively in games and athletics. In planning the new technical education it is important that some provision should be made for physical recreation. Part-time students should take an increasing part in the social and athletic activities of their colleges.

The report stresses the importance of hostel accommodation at colleges with full-time students. A growing number of authorities have already provided hostels and from an economic point of view they may be necessary to ensure that full-time and 'sandwich' courses are filled.

Finally, the report insists that appointing committees, principals and heads of departments should ensure that candidates for posts are made aware that a liberal approach to teaching is expected and will be encouraged; and that newly appointed teachers are encouraged, and if necessary urged, to take advantage of facilities for adapting their techniques to the needs of an ever-changing world.

The most important duty of the local education authority is the training of teachers, both part-time and full-time. If a new approach, new techniques and a new philosophy of technical education are needed, it is to the training of the right kind of teachers that most attention must be paid.

FERTILIZATION IN ORGANISMS

Fertilization

By Lord Rothschild. Pp. ix+170+5 plates. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1956.) 18s. net.

FERTILIZATION, by which is meant the spermatozoal activation of an ovum, with the subsequent fusion of the male and female pronuclei, has always been one of the most enthralling topics of biological study. Lord Rothschild's monograph takes the subject up to the formation of the zygote, but focuses mainly on the changes which take place during the phase of activation. The opening chapter deals with the visible changes of fertilization in various plant and animal forms. The next three are concerned with the fact that the spermatozoa and eggs of many animals and plants incorporate substances, sometimes called gamones, which have specific effects on the gametes of the opposite sex. Among the many topics dealt with in this section of the book are the reciprocal induction of spawning (for example, the spawning of a male sea-urchin may incite every other male urchin in a tank to start shedding its spermatozoa); the possibility that water in which the eggs of certain species are maintained may, in certain circumstances, stimulate increased metabolic activity in spermatozoa; the immunological and chemical nature of different gamones; and also the principles underlying the chemotaxis of spermatozoa towards the eggs, a process which occurs in certain species of plant, such

as ferns, and in which chemical substances that diffuse from the eggs into the surrounding medium exert an attraction on spermatozoa. The fascinating idea emerges that sperms which are subject to chemotaxis possess "sense organs not fundamentally different from those which cause a moth to fly towards a light".

The two chapters that follow deal with the metabolism of eggs, particularly with the sources of energy which permit of the various changes that take place during fertilization. Here the discussion is focused on the eggs of the sea-urchin and oyster, in which there are both anaerobic and oxidative pathways by which carbohydrate is broken down. A variety of metabolic changes of a different kind are listed and summarized in the following chapter, which precedes an account of other changes that occur in the egg at fertilization, including changes in the birefringence and tension of the cortical zone. The processes which inhibit polyspermy are dealt with in a chapter on their own, Lord Rothschild holding, as a tentative hypothesis, that "at the moment of attachment of the fertilizing spermatozoon to the egg surface, a change in cortical structure passes over the egg" which "reduces the chance of refertilization by a factor of twenty and catalyses the production of a sperm-impermeable layer at the egg surface". This impermeable layer is established in about sixty seconds, and its integrity depends, *inter alia*, on the existence of divalent cations in the external medium. The subject of polyspermy is followed by a short chapter which summarizes certain bio-electrical observations that have been made on the egg at fertilization, but which so far have revealed little of importance, except that there is an increase in membrane capacitance when sea-urchin eggs are fertilized. Lord Rothschild tells us that there is nothing new to say about the specificity of fertilization, and he concludes his book with a final chapter that lists fifteen subjects which, in his view, would repay further investigation.

There is a general index of subjects discussed, as well as an extensive references and author index. Particular attention is paid throughout to the correct systematic designation of the plants and animals that are referred to, and a separate index provides synonyms and vernacular names for the different species. The general biologist might have been further helped if the author had also included a summary indicating which plant and animal types had yielded what kind of information about the mechanisms of fertilization. A great deal of our present knowledge is apparently derived from work on echinoderm eggs, and it would have been helpful to know how well or widely based are the more important generalizations that relate to the subject.

The book is concise, but is so well constructed that it is always lively and readable. It is also scholarly and critical, and the author, who is a distinguished worker in the field, does not disguise the fact that on certain subjects his opinions are not shared by other investigators—although the arguments are marshalled in such a way that it is difficult for the non-specialist to doubt any of the conclusions that are stated. This is partly because the author's approach to his subject-matter is admirably clear-cut, and because the reader is not allowed to forget that what is discussed relates to carefully formulated questions. "The most we can do," writes Lord Rothschild, "and all we need to do, in describing some biological problem, is (ultimately) to make a time-sequential analysis of the phenomenon in the language of physical chemistry." This view may define the field of biology more rigidly than some biologists would like, but there can be no question that, having defined it in this way, Lord Rothschild pursues his theme with the strictest regard for scientific discipline—by asking real questions; by stating real answers when they have been found; and by acknowledging, where necessary, difficulties and ignorance. He provides no addition to the many theories of fertilization that have been advanced by other workers. But he goes one better by ending his story with a clear statement of the more important issues that call for elucidation before a new general hypothesis need be formulated.

S. ZUCKERMAN

AUTOMATIC DIGITAL COMPUTERS

Automatic Digital Calculators

By Dr. Andrew D. Booth and Dr. Kathleen H. V. Booth. Second revised edition. Pp. ix+261. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1956.) 32*s*.

Automatic Digital Computers

By Dr. M. V. Wilkes. Pp. x+305+9 plates. (London: Methuen and Co., Ltd., 1956.) 42*s*. net.

IT is only natural that the above two books should cover to some extent the same ground. The first of them has clearly proved its worth by having exhausted its first edition in some two and a half years, a fact which shows without further comment that a need existed for such a book, and that it met that need. As for its main contents, they have been sufficiently described and criticized by the present reviewer in *Nature* (175, 484; 1955), and there seems to be no necessity to alter or amplify what is said there. But in fact the book has been increased by a fair amount of new material, notably the description of the transistor and what it does, in the middle chapters (9, 10 and 11), and of automatic programming procedures as lately introduced, this forming a supplement to Chapter 16. There is also a description of ferro-electric matrix storage. Some idea of the amount of work published on automatic digital computers in the past three years or so is given by the more than doubled bibliography, which now extends from p. 235 to p. 244. The book, as before, can be recommended as clear and painstaking.

The second book is by the well-known director of the Cambridge University Mathematical Laboratory, and, though he gives generous and extensive acknowledgment to others, bears on every page the impress of his own hand. It begins, as it almost necessarily must, with the historical summary—Babbage, Georg and Edvard Scheutz, and so on—and moves quite quickly and naturally from this to the *ENIAC* and *EDVAC* computers. In the most thorough manner we then have the principles of logical design, leading to the principles of programme construction, by which time we are well under way. Chapters on relay computers, storage, electronic switching and computing circuits follow, concerning which it can only be said that the reader is led on in the most natural manner, and with excellent plates and tabular illustrations.

Much the most interesting chapters to the present reviewer are Chapter 7, on the design and operation of digital computers, and the five-page appendix,

"Machinery and Intelligence", which is to be thought of as a short chapter. It would seem that Chapter 7, with all that it says about organization, staffing, business purposes and industrial processes, is likely to be the one of most general value in the whole book.

As for the appendix, with a certain relief the present reviewer discovers the last clause of the final sentence to be: "but I do not see them [namely, the machines] behaving like human beings". Neither do I; if ever I see a machine looking in at the door at me, and complaining at having been unsuitably programmed, I shall take suitable consultation, not about it, but about myself.

A. C. Aitken

PLANT EVOLUTION

Features of Evolution in the Flowering Plants

By Prof. Ronald Good. Pp. xv+405. (London: Longmans, Green and Co., Ltd., 1956.) 30*s*. net.

THE evolution of the flowering plants is probably as great a mystery as it was a century ago, and it deserves much more critical consideration than it has hitherto received. The study of the problem now presented by Prof. Ronald Good should interest both botanists and a wider public. Those who study plants from any aspect, taxonomic, structural or physiological, can scarcely remain indifferent to the problems of the origin and evolutionary development of the plants which form the major part of the surface vegetation of the world to-day, and of which some 250,000 distinct species are recognizable. At the same time, these problems affect a wider range of studies, since the flowering plants form the ultimate source of nutrition of almost all the terrestrial animals.

At present we have very little, if any, idea as to how these forms have evolved, and Prof. Good does not attempt to present theories or speculations on how they have come to be as we see them to-day. Instead he gives a view of the group "primarily as an achievement of those processes which are called evolution". He briefly surveys the vast number of living types, indicating the general relationships between the principal groups recognized by taxonomists from a study of their floral characters. Then, selecting a large and distinct family of Dicotyledons, the Asclepiadaceae, he examines it more closely to show how evolution has expressed itself within a relatively isolated family. He discusses the difficulties which arise when we try to envisage the course and possible causes of evolutionary differentiation in this series of plants, which have a most remarkable mode of pollination. He next considers the appearance of floral aggregation in many different families, and goes on to survey the flowers of the Compositae, in which floral aggregation is most marked, and may have contributed to making this family the largest and most widely distributed group to-day. This leads to the consideration of superficial resemblances of many kinds between different plants which are apparently quite unrelated, demonstrating "that evolutionary repetition of this sort has been a feature in the history of these plants". The concluding chapter is a summary and discussion of the problems which have been presented.

Prof. Good has shown very clearly how difficult it is to explain the appearance of such a great variety of organisms in terms of the ideas advanced by different writers since Darwin. But he seems to view the question almost entirely from the aspect of floral structure and the mechanism of reproduction, and from this aspect close study seems to raise more problems than it solves. Near the end of the book the author recognizes the possibility that the facts may be susceptible to some explanation other than the idea of gradual transformation. He does not suggest what other explanations there may be, but some readers may well feel that little progress will be made until we know more about the biochemical constitution and the vital processes which go on during the life of the plant. May it not be the physiological make-up, rather than the structural characters, which determines survival and is responsible for evolutionary changes that have occurred in the group during many millions of years in a world where climatic and environmental changes have constantly taken place?

This stimulating book could have been improved by giving the reader more help to understand the illustrations. Few ordinary persons are familiar with the floral structures in the Asclepiadaceae, and the text would be followed more easily if the drawings had been labelled and more fully explained.

H. Hamshaw Thomas

COLLECTED WORKS OF LUDWIG SCHLÄFLI

Ludwig Schläfli, 1814–1895

Gesammelte Mathematische Abhandlungen. Herausgegeben vom Steiner-Schläfli-Komitee der Schweizerischen Naturforschenden Gesellschaft. Band 1: Pp. 392. 56.15 Swiss francs. Band 2: Pp. 381. 56.15 Swiss francs. Band 3: Pp. 402. 59.30 Swiss francs. (Basle: Verlag Birkhäuser, 1950, 1953 and 1956.)

DURING his long life (1814–95), Schläfli contributed in many ways to the algebra, geometry and analysis of the nineteenth century. Yet his influence on geometry might have been much more considerable had the length of one of his greatest memoirs not prevented its publication at the time of its production in 1852; this is the famous "Theorie der vielfachen Kontinuität", first made public in 1901. It occupies 220 pages in the first of the present set of volumes, and not unnaturally overshadows the rest of the contents of that volume. Essentially, it is a systematic essay on the extension of familiar metric properties of three-dimensional space to space of n dimensions. The first section deals with linear spaces and the configurations bounded by them, leading up to the study of the regular polytopes, a topic which has been developed on the basis of Schläfli's work by a number of contemporary mathematicians, and in particular by Coxeter. The second section discusses the hypersphere and its geometry, with special reference to the spherical simplex and its connexions with the regular polytopes. The final section contains generalizations of quadric properties and related topics. Had this paper appeared in 1852, would it have had any substantial effect on the general line of geometrical development during the next half-century? Would the flow of effort on projective lines have been deflected, and would Cayley have promulgated his famous phrase of 1859: "projective geometry is *all* geometry"? Possibly Cayley did not intend this to be taken as literally as it often has been taken; in any event, his line of thought was

not very far removed from that of Schläfli, for whom Cayley had a high regard—enough for him to undergo the labour of translating some of Schläfli's papers into English so that they might be published in Britain.

Volume 2 is mainly on algebra and geometry. The particular gem, by which Schläfli's name is perhaps best known, is the theorem (1858) of the 'double six', concerning the intersections of two pairs of six lines in space. This occurs in a memoir on the classification of cubic surfaces, for the double six configuration is closely related to the twenty-seven lines on the cubic surface. But the theorem does not depend on the theory of the cubic surface, and many other proofs have been given; a melancholy interest attaches to the ingenious proof which relates the result to the celebrated theorem of Miquel on the foci of a set of parabolas, for this was devised by the brilliant young English geometer, Wakeford, shortly before his death on the Western Front in 1916.

Analysis occupies most of the third and final volume. There is, for example, a paper which has the air of being much more modern than its date (1875), in which the asymptotic expansions of the Bessel functions of the third kind are investigated; Watson remarks that this does not appear to have received the attention it deserves. Another paper of importance deals with spherical harmonics. Heine had unsuccessfully attempted to give appropriate definitions of the general harmonics $P_n^m(\mu)$, $Q_n^m(\mu)$ for complex values of m and n; Schläfli solved the problem for the zonal harmonics ($m = 0$), by means of single-circuit integrals. The general problem was solved somewhat later, by Barnes and Hobson independently, the former using single-circuit integrals and the latter double-circuit integrals of the Pochhammer type.

In spite of some early struggles, Schläfli seems to have had a quiet and happy life, winning the affections of many generations of pupils, and contributing substantially to the pure mathematics of his time. These three volumes, beautifully produced by Verlag Birkhäuser, and well edited with sound but unobtrusive comments by Kollros, Burckhardt and Hadwiger, are an appropriate memorial to Schläfli's versatile, polished craftsmanship.

T. A. A. Broadbent

PLANETARY NEBULAE

Gaseous Nebulae

By Prof. L. H. Aller. (International Astrophysics Series, Vol. 3.) Pp. xvi+322. (London: Chapman and Hall, Ltd., 1956.) 63*s*. net.

I HAD hoped on opening this book to find that it dealt chiefly with the diffuse gaseous nebulae, which during recent years have become of special interest because of their connexion with interstellar matter and the problems of radio astronomy, with the formation and existence of the hot Population I stars, and through these with important problems of the history and structure of the Milky Way. Although "Gaseous Nebulae" indeed devotes some attention to these objects, its chief concern is with the planetary nebulae, and we are informed that Prof. Lyman Spitzer is at present preparing a book on interstellar matter and the diffuse nebulae. Topical interest in the planetary nebulae (which have nothing to do with planets) is less intense, although for more than half a century they have offered fascinating problems to both theoretical and observational astronomers. They are an order of magnitude smaller than the diffuse nebulae, each is centred on a hot star; although often complicated, they show regularities of shape approximating to spheroidal shells, or rings, or even helices; they appear to belong to Population II, and they have no close connexion with interstellar matter.

Nevertheless in some respects, for example, in their spectra, these two distinct classes of nebulae have much in common. Both consist of highly rarefied gas, giving a bright line spectrum, with a considerable number of 'forbidden' lines. The spectrum is produced by a fairly well understood mechanism of ionization, recombination and electron collision, dependent in the first place on dilute ultra-violet radiation from one or more hot stars. But although the general operative principles are known, detailed calculation of the spectrum, or of the physical conditions within the nebula, leads to most formidable complexities. Further, the best observers and the most powerful telescopes are unable with present techniques to give the theorist much of the information which he knows to be of vital importance, and he is too often reduced to forcing a way through his problems by the aid of drastic and not always very convincing simplifications.

Prof. L. H. Aller is a well-known expert in planetary nebulae and here we have a book by an enthusiastic specialist, for specialists. According to the preface, it is based on a much-revised manuscript twelve or more years old. I suspect that the core of the book, Chapter 4 ("Physical Processes in Gaseous Nebulae") and Chapter 5 ("The Forbidden Lines"), which also appears to be the most carefully written part, comes from this manuscript. The other chapters, dealing with types of gaseous nebulae, methods of observation, distances and dimensions, the spectra, the illuminating stars, the structure and internal motions, and the diffuse gaseous nebulae, contain a great amount of very varied and detailed information, too much for clarity, and seem to me to need more thought in arrangement and selection. The specialist, already well acquainted with the subject, may be able to browse with profit, doubtless annotating liberally as he goes. Reading critically and adding much from his own experience, he will realize once more the complexities of the subject, the weaknesses and difficulties of current theories, and the points at which more measurements are urgently needed. He will also find new and hitherto unpublished material, and will be provided with much food for thought.

But it seems to me that the less-advanced student, or the inquirer from another branch of physics, will find complicated matters presented too briefly. He is likely, too, to have difficulty in seeing the wood for the trees and may find himself somewhat bewildered. I cannot recommend the book for such a reader, unless he has a well-informed mentor near at hand to provide a running commentary of elucidation, for there is much which cannot be properly understood without a very wide knowledge of both theoretical and practical astrophysics. Even then, many questions will remain unanswered, some of them pointed out by the author, some not.

There are a number of misprints, including three curious examples on pp. 17, 20 and 229, respectively. Long and useful bibliographies are provided at the end of each chapter.

R. O. Redman

Supplement to the Dictionary of Gardening

A Practical and Scientific Encyclopædia of Horticulture. Edited by Patrick M. Synge. (Royal Horticultural Society.) Pp. x+334. (Oxford: Clarendon Press; London: Oxford University Press, 1956.) 42*s*. net.

THIS supplementary volume, published five years after the main work, is in two parts. The first contains the promised lists of recommended varieties of flowers, fruit and vegetables, and also a valuable article on fertility and infertility in fruit. The second, and rather larger, is "Additions and Corrections".

With a compilation of this nature, it must be very difficult indeed to decide when to call a halt to revisions and commit to press, and some matter must inevitably be out of date even when it appears. Also, varieties of cultivated plants are so numerous and multiplying so rapidly that it would be unfair to expect recommended lists to be entirely up to date, comprehensive, or really satisfactory to the specialists in any particular group.

Nevertheless, it is disappointing to find columns of bare names (for example, vegetable marrow), quite misleadingly fragmentary selections (for example, *Primula*, hardy), and many lists like trade catalogues in which several varieties share paraphrasings of one description, with few references to distinctive virtues, and even more important, vices. Many omissions are obvious. Where, for example, are the 'Cambridge' strawberries and brussels sprouts, or the Pacific strain of delphiniums? Yet space is devoted, in an already over-bulky horticultural reference work, to such things as detailed variation within the *Alchemilla vulgaris* aggregate.

The list of contributors to Part 2 is a guarantee of the solid worth of many articles. A more critical selection of genuinely horticultural matter is desirable when the supplement is itself revised and re-issued.

S. Clay

An Outline of Atomic Physics

By Prof. Oswald H. Blackwood, Thomas H. Osgood and Prof. Arthur E. Ruark. Third edition. Pp. x+501. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 60*s*. net.

FOR the third edition this well-established introduction to atomic physics has been completely rewritten, and the main advances in the subject up to about 1953 are very lucidly explained. The treatment is chiefly descriptive, but the authors give a good elementary outline of what wave-mechanics is about and indeed discuss in some detail the difficulty of arriving at a theory of the deuteron. The account of cosmic rays and of the new particles discovered in this field is fuller than anything which has yet found its way into books of this standard. The final chapter on the Michelson–Morley experiment and the development of relativity theory is also very good.

Little is said about the fascinating subject of ferromagnetism, and the few lines devoted to this are rather confusing; also, it is hard to interpret the statement on p. 76 that electromagnetic radiation is the common carrier that transmits energy between electrons and nuclei. But the marks lost for these minor points are recovered (with a handsome bonus) for the treatment of the elementary particles, for the "model for visualizing their spins, charges, and masses", and for the clear explanation of the concepts of statistical character and parity. A number of problems, complete with answers, and a list of references for further reading are provided.

The preface states that the original aim of the book was to equip non-specialists to keep abreast of current progress in physics; in this it should be most successful.

G. R. Noakes

Introduction to Chemical Engineering

By Walter L. Badger and Prof. Julius T. Banchero. (McGraw-Hill Series in Chemical Engineering.) Pp. ix+753. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 71*s*. 6*d*.

THE heading of this book should surely be "Badger and McCabe's Elements of Chemical Engineering, third edition revised and enlarged by W. L. Badger and J. T. Banchero", for this is what the book is, in spite of the change of title and authors. A large proportion of the letterpress is identical with that in Badger and McCabe's second edition, both books have sixteen chapters with similar titles and many of the illustrations in the older work appear in the new volume with very minor alterations, made perhaps to substantiate the claim in the preface that "the illustrations have all been specially drawn for this book"; and yet the earlier book is not even mentioned.

Some superfluous matter has been omitted, and nearly all the chapters have been enlarged and brought up to date, especially those on evaporation, distillation, extraction, humidity and gas absorption; and the book retains the valuable characteristic of emphasizing the importance of plant and its constructional details. The problems and worked-out examples are nearly all new. In order to maintain the same thickness and reduce the weight, the paper is now thinner and the lines longer and closer together, allowing an increase of about 35 per cent in the contents. Some of the diagrams are not up to the standard usually found in this series, and the general appearance and clarity have suffered.

In spite of these minor defects, there is little doubt that the book will continue to enjoy the popularity of its predecessor of 1936, which in those days was generally regarded as the Bible of the chemical engineering student.

H. E. Watson

The Planet Venus

By Patrick Moore. Pp. 132+8 plates. (London: Faber and Faber, Ltd.. 1956.) 15*s*. net.

THE publisher's note about this book states that it is the first serious book in any language devoted to Venus. This is not surprising, as so little is known about the physical conditions on Venus; even the period of its rotations is not known with certainty. But this book is disappointing in many ways. Space is given to the discussion of such matters as the canals of Venus, which are based on observations that are discredited, and of the ashen light, which is a purely instrumental effect, being never observed with reflecting telescopes but only with refractors that are not perfectly achromatic. In some other respects the book is quite inadequate. For example, there is no discussion of the polarization curve; no reference is made to the variation of polarization over the disk or of the appearance and disappearance of areas of abnormal polarization. Such observations have an important bearing on the nature of the atmosphere of Venus and of the clouds in its atmosphere. As an account of the present state of knowledge about Venus, this book cannot be recommended.

H. Spencer Jones

J. J. THOMSON*

By Sir GEORGE THOMSON, F.R.S.
Master of Corpus Christi College, Cambridge

JOSEPH JOHN THOMSON was born on December 18, 1856, in a suburb (Cheetham) of Manchester. His father was a bookseller and publisher, specializing in old books, and the family was of Scottish origin. He came to be very well known to the Royal Institution, where he was non-resident professor of physics, and he often gave the Friday evening discourse.

To the student of physics of the present day he is known as the discoverer of the electron. Actually that word was coined before his work on the subject began and he preferred to use another; but as I hope to make clear, he did more than any other single person to prove the objective existence of the entity we call by that name, and to provide the theoretical ideas on the subject with experimental proof. But he was not a man of one discovery, and I wish to bring up in rapid review as many as I can of the departments of physics in which he was interested, and which sometimes were connected by unexpected sequences of ideas.

He started as a mathematician—he was second wrangler when Larmor was senior—and his earliest important work was as a disciple—he was never the pupil—of Clerk Maxwell. Maxwell's theory of electricity was not well appreciated when it came out in 1873. It was indeed rather obscure, since the physical conceptions underlying Maxwell's ideas did not appear clearly in the final mathematical form he adopted. 'J. J.', as he was always known, developed the consequences of the theory and showed in particular that a moving charged sphere had additional mass as a result of its charge—the first hint of Einstein's $E = mc^2$—and that the electromagnetic waves carried momentum as well as energy along their rays.

Then he became interested in vortex rings, of which smoke rings are a good example. Vortex rings appealed to nineteenth-century physicists, notably to Kelvin and to Helmholtz, as a possible explanation of atoms, because of their permanence. "It is indestructible and indivisible, the strength of the vortex ring and the volume of liquid comprising it remain for ever unaltered, and if any vortex ring be knotted or if two vortex rings be linked together in any way, they will retain for ever the same kind of be-knottedness or linking." So when vortex rings were set as a subject for the Adams Prize, 'J. J.' took up their theory, and the prize-winning essay published in 1883 contained some interesting suggestions as to the way in which vortex atoms might link together to form molecules. Two, three, four, five or six can be linked together in a special way, but seven or more are unstable.

This early and forgotten theory led 'J. J.' to his earliest experiments on gaseous discharges, the subject he was to make peculiarly his own, and which was to occupy his attention into advanced old age. The connexion may not be obvious, but the theory indicated that the electric discharge in a gas would be associated with dissociation of the molecules in a measurable fashion. The experiments were not in fact, very conclusive, but they led Thomson on to study other properties of the gaseous discharge, and especially the electrodeless discharge, for which he retained a life-long affection. More important than the results obtained was the experience with this kind of experiment, which was so useful to him later on.

The discovery by Röntgen of X-rays in 1895 is a turning point in physics. 'J. J.' was quick to take advantage of it and he and Rutherford showed—about the same time as some other workers—that the X-rays made a gas conducting, thus providing a manageable method of ionization, a word they used in their paper. We shall see how valuable this was in the discovery of the electron.

The fundamental importance of the electron, as was fully realized at the time, is the proof that all matter contains at least this one common constituent, and that the atoms of nineteenth-century chemistry are not separate independent entities, as was then generally supposed.

The actual approach to the electron, the first of the common constituents, came from two different directions, neither of which seemed at the time to have much to do with the structure of the atoms of ordinary matter. Faraday's laws of electrolysis early in the century had produced very strong evidence, which one now feels that the men of the time were very dense in ignoring, that electricity is somehow done up into units of which one, two or three, rarely more, may be attached to each individual atom. Towards the end of the century people woke up to this, and Johnstone Stoney coined the word 'electron' for this hypothetical unit; but as yet it had no other properties. Its magnitude could be estimated, though only very crudely. There was no evidence that it existed alone, apart from electrified matter. It might just have been a unit of exchange in Nature's bank, like the 'money of account' in those countries where the unit of accountancy corresponds to no actual coin.

There were electron theories of a kind in the nineteenth century, but the first that led to anything of importance was that of Lorentz in the early 90's, which immediately explained the discovery of Zeeman in 1896 that the spectrum of the light from a sodium flame was modified by a magnetic field. It is interesting to recall, here in the Royal Institution, that Faraday's last recorded experiment was an unsuccessful attempt to detect this, and that Zeeman, who had read Faraday's work, was deliberately repeating it with more modern equipment.

The other line of approach, in which 'J. J.' was the leader, was given by cathode rays. These can be observed when an electric current goes through a very rarefied gas. They are more familiar to-day, in a slightly modified form, as the working medium of a television tube. They had been known from the middle of the century and their nature hotly disputed. The question became international; on the whole the British and the French held the view that

* Friday Evening Discourse at the Royal Institution delivered on December 7.

they were some sort of particle, whereas the Germans thought that they were waves and more akin to light. Of course, both were right, but the reconciliation was to come much later.

Cathode rays are deflected by a magnet as a stream of electrified particles would be, and Perrin showed that if shot into a box they gave it a negative electric charge. 'J. J.' combined these two experiments and showed that the magnetically deflected rays took their charge with them. More important, he showed that the deflexion was the same for all rays produced by a discharge of the same voltage whatever the gas and the material of the cathode. This experiment, which was published in February 1897, convinced him, I think, that they were not just 'electricity', whatever that mysterious entity might be, but part, and a fundamental part, of matter as well.

But more was needed, for there were serious difficulties. Hertz had found that they were not deflected by an electric field as charged particles ought to be, and Lenard at Heidelberg had found that they would go right through a thin metal window into the air outside. This seemed impossible if they were charged atoms—and no one had thought of any smaller particle.

The dramatic occasion was a discourse in the lecture room of the Royal Institution, given on April 30, 1897. After showing the modified Perrin experiment and photographs of the deflected cathode rays, he passed to the matter of the missing electric deflexion. The observation, though right in itself, was misleading. When the field was applied (as the experimenters thought) nearly all of it was neutralized by charges produced by the rays themselves in the rarefied gas, so that the region where the rays actually went was devoid of field. The charges do not neutralize magnetic fields, hence the curious discrepancy. 'J. J.' managed to get the vacuum better and found a deflexion by electric fields. Later on he used this deflexion balanced against a magnetic field to find the ratio of the charge to the mass of the particles and their velocities in a way described in every text-book of electricity; but actually on that evening he described another way of measuring the same quantity in some ways more direct. He measured in fact for certain rays their magnetic deflexion, and the heating effect that corresponds to the transport of a unit of charge. In terms of symbols, the first gives e/mv and the second e/mv^2, from which e/m and v can be found. Now e/m is a critical quantity. The Faraday experiments had found it for ordinary atoms. It varies with the kind of matter, but even for the lightest atoms (hydrogen) the charge per unit mass, written e/m, was more than 1,000 times too small. Either each cathode ray had a charge 1,000 times the unit, or a cathode ray is more than 1,000 times lighter than the lightest chemical atom. But all the cathode rays had the same e/m, no matter what the gas or what the metal used for the cathode from which they came. Since in Faraday's experiments the charges seldom exceed 3 units, a constant value of more than 1,000 seemed most improbable, so the particles of cathode rays must have a sub-atomic mass which is the same whatever material they came from.

In the next two years, 'J. J.' brilliantly completed the proof and added new evidence of the universality of what he, not wishing to prejudge the issue of their identity with the unit charge, called 'corpuscles'. He found he could get them from hot wires, and from metals exposed to ultra-violet light. In all cases e/m was the same as for cathode rays within a reasonable experimental error, whatever the nature of the wire or metal. Moreover, he adapted a clever method, just discovered in the Cavendish by C. T. R. Wilson, of making small charges visible by collecting drops upon them, to measure the charge of the 'corpuscles' in the ultra-violet light experiment. It came out within the range expected for the Faraday unit; and though this was wide, it was clear enough that he was not dealing with something more than 1,000 times as large. Hence the corpuscle was at least 1,000 times lighter than the lightest atom. It was established as a universal constituent of all matter; not the only one obviously, since ordinary matter is electrically neutral and 'J. J.'s' corpuscles were charged, but a true universal entity, more nearly recalling the philosophies of the Greeks than nineteenth-century chemistry. In the very paper which described the now classic e/m experiment on cathode rays 'J. J.' turned to the next stage. Granted that electrons are universal constituents of matter, how do they fit in? Lenard's experimental result that the distance a cathode ray could go through matter was inversely as the density over a wide range and independent of its chemical nature or physical state, seemed to 'J. J.' to give strong support for the view that atoms contained electrons in number proportional to the mass of the atom. He considered, correctly, that the collisions of the rays in going through an atom would be rather with the individual constituent electrons than with the atom as a whole, so Lenard's relation implied that the number of electrons per gram is the same for all substances. Ever on the look-out for a model, he adopted an experiment of the American physicist Mayer, which seemed to him to suggest very strongly something like the periodic table.

Now if this has any validity, even in an order-of-magnitude fashion, there will not be many thousands of electrons in an atom, probably only a few. Therefore, the main mass of atoms cannot be due to electrons; presumably it is supplied by the positively electrified component.

Both these questions had to wait while knowledge accumulated on the behaviour of electricity in gases, on the action of X-rays, and on the behaviour of radioactivity, of which Rutherford made himself the master, using, in each case, the electron as a master key.

Much of this work was done at the Cavendish Laboratory. Here the first research school of the modern kind ever to operate in Britain was working all out. Seeing that it started with Rutherford and Townsend as the first two research students, soon to be joined by C. T. R. Wilson, Langevin, Barkla and many others, this is not surprising.

It was, I suppose, the happiest period of 'J. J.'s' life, for though he was an intense individualist in his own work, he enjoyed the companionship of other workers. His own enthusiasm stimulated them as much as his curious insight helped to exorcise the devils that inhabit physical apparatus. He got back enthusiasm in return, the enthusiasm which he so valued as the supreme quality of a good physicist.

In 1906 he was able to make an estimate of the number of electrons in an atom—corpuscles as he still called them. It was a theoretical paper based on the experimental work of Barkla and Rutherford, and using his own formulæ for the scattering of electromagnetic waves by charged particles, that is, X-rays by electrons, and of fast electrons by resting

ones. Three methods, the scattering of X-rays, the penetration of β-rays through matter, and less accurately the refractive index of gases, all led to the conclusion that the number of electrons in an atom is of the same order as the chemical atomic weight.

But what then of the positives, which must therefore somehow contribute the lion's share of the mass of all atoms? 'J. J.' supposed that the atom was like a gooseberry with corpuscles as the pips and the neutralizing positive charge spread out continuously rather like the edible part of the gooseberry. It was left for Rutherford to discover the nucleus. 'J. J.'s' reason for his choice was a rational one in the days when no one questioned Maxwellian electrodynamics. While on the inverse square law a solar system can be stable if the planets *attract* one another, it is inherently unstable—for more than one planet—if they *repel*, as electrons must. The sphere of distributed electricity gets over this objection. The Mayer experiment which gives much the same field as a distributed electric charge only works in two dimensions; in three dimensions these rings would be unstable, but stability can be restored by making them spin.

A year before, in 1905, 'J. J.' had made his first experiments on positive rays or canalstrahlen. These had been studied by Wien, who had shown that they have values of e/m, and so probably masses, of the order of those of ions in electrolysis. However, Wien's experiment did not allow him to measure e/m with any accuracy, and indeed seemed to indicate that it varied continuously. This was due to bad vacua. By improving the technique, 'J. J.' was able to show that the rays consist of atoms and molecules which have lost electrons in the discharge and been accelerated towards the cathode by the strong electric field in the Crookes' dark space.

The positive rays were thus no new revolutionary particles, but the gaseous ions which the Cavendish had been studying now for a decade. As so often happens when a better technique is applied to something crudely known, the unexpected turned up in the end; but the first result was to produce for the first time experimental evidence for what everyone had believed for no good reason, namely, that all the atoms of an element had the same mass, and that atomic weight was definite and was not merely a statistical property of large numbers, a mere average. The parabolæ, which appeared on the plates which his assistant Everett, and later Aston, exposed, and which he measured in a little frame sitting perched up on an office stool, each correspond to one value of e/m and so to one mass, the charge being that on an electron, with sign reversed, or a small integral multiple of it.

Some odd things certainly turned up—compounds which disobeyed the laws of valency, triple hydrogen and the like. Then it was found that when neon was in the tube two parabolæ appeared where only one should be. Was the second perhaps a hydride in spite of neon being an inert gas? There were weighty reasons against, and when the First World War came and stopped work at the Cavendish, both 'J. J.' and Aston believed that the two parabolæ were due to two subspecies of the neon atom, like the isotopes Soddy had found among the radioactive elements. But there was no absolute proof. After the War, as is well known, Aston's pertinacity and experimental skill not only supplied the proof, but also by the greatly improved technique of his mass spectrograph showed that neon, so far from being unusual in having isotopes, was perfectly normal—that indeed its two isotopes were a modest allowance often exceeded by other elements.

'J. J.' always believed that the method of positive-ray analysis had great possibilities for chemists because of the small quantities of material required. It would have pleased him greatly to see its application nowadays to a variety of technical problems.

Though I fear this lecture has been crowded, I have had to omit much. I have only touched on his theoretical work, and said nothing of his suggestion of the 'spotted wave front', which anticipated Einstein's treatment of light quanta, nor of his important work on the electron theory of metallic conduction. Though his experimental work is better known, he started and finished as a theoretician. His fellowship thesis on the relation of dynamics to physics and chemistry helped to clarify ideas on energy. His theory of the recombination of ions is still valid. The "Conduction of Electricity through Gases", for many years a Bible of physics, contains many pieces of his own theory.

His attitude to theory is interesting. Though a first-rate mathematician, he liked something he could visualize or draw in a diagram on the back of an envelope with a halo of equations around it. Hence his life-long attraction to the concrete 'tubes of force' of Faraday and Maxwell, and truly even now there are problems for which these are the most useful picture. The research, so he told me once, that he most enjoyed doing was one on conformal representation in electrostatics. The trouble with experiments, he said, was that you had infinite labour in getting the apparatus to work, and when it did work the experiment was over too quickly. For him the apparatus existed for the experiment, never the experiment to justify the apparatus.

Though he was a man of unusually wide interests and sympathies, physics was his life. He believed that it was bad for a man to do research continuously and that interruptions were sometimes helpful, especially the interruptions of teaching, in sending a man back to his problems with a fresh mind and perhaps with fresh ideas. This made him perhaps more tolerant than he would otherwise have been of his teaching and administrative work, which he took very seriously; but his strong sense of duty did not always extend to answering letters.

He enjoyed lecturing—but perhaps not preparing lectures—especially in the Royal Institution, and would, I think, have been glad that his centenary is honoured here.

I will conclude with a quotation which expresses his faith in the future of physics:

"A great discovery is not a terminus, but an avenue leading to regions hitherto unknown. We climb to the top of the peak and find that it reveals to us another higher than any we have yet seen, and so it goes on. The additions to our knowledge of physics made in a generation do not get smaller or less fundamental or less revolutionary, as one generation succeeds another. The sun of our knowledge is not like what mathematicians call a convergent series . . . where the study of a few terms may give the general properties of the whole. Physics corresponds rather to the other type of series called divergent, where the terms which are added one after another do not get smaller and smaller, and where the conclusions we draw from the few terms we know, cannot be trusted to be those we should draw if further knowledge were at our disposal."

RECENT WORK ON NUCLEIC ACIDS

AN informal discussion on nucleic acids, held under the auspices of the Colloid and Biophysics Committee of the Faraday Society, was held during October 12 and 13 in Manson House, London (Royal Society of Tropical Medicine and Hygiene). The chair at the opening session was taken by Prof. J. A. V. Butler, who arranged the meeting. At subsequent sessions Sir Alexander Todd, Prof. E. Chargaff and Prof. R. M. Herriott took the chair. Twenty-six papers were presented.

In the first session, Dr. J. Pouyet, J. Hermans and Dr. R. Vendrely discussed preparations of deoxyribonucleic acid of the two categories described by Sadron at the Brussels Congress in 1955. Further preparations of deoxyribonucleic acid from calf thymus have been made which are of the more compact configuration of category 2, and it has been shown that the absorption at 260 mμ is lower for these preparations than for those of category 1. Experiments suggest that the treatment of the nucleoprotein by salt and alcohol may affect the size and configuration of the deoxyribonucleic acid prepared from it. In a later paper, Dr. R. A. Welsh showed that if nuclei from calf thymus are extracted with 0·14 *M* sodium chloride, the deoxyribonucleoprotein can be dissolved in molar sodium chloride and precipitated in a non-fibrous form, in contrast to the fibrous precipitate which is obtained if the nuclei are extracted in water. To some extent the structural changes involved can be reversed, and a fibrous form can be prepared from the non-fibrous nucleoprotein. A further problem in the preparation of deoxyribonucleic acid from calf thymus was raised by Dr. K. V. Shooter, who showed that the small amounts of residual protein (less than 1 per cent) usually found in preparations may markedly influence the physical properties. Treatment with chymotrypsin suggested that 26 per cent by weight of the deoxyribonucleic acid may be cross-linked by the residual protein. A method of preparing deoxyribonucleic acid, involving the partition of a tissue homogenate between phenol and water in the presence of sodium chloride and the chelating agent *p*-amino-salicylic acid, was described by Dr. K. S. Kirby. Using this method, a high yield of deoxyribonucleic acid free from protein has been produced. The various techniques available for the isolation of deoxyribonucleic acid from the bacteriophage D_4 of *Salmonella enteritides* were discussed by Dr. R. Wahl, Dr. M. Joly and Dr. E. Barbu. Viscosity measurements in salt solutions showed that the reduced viscosity of the deoxyribonucleic acid from this phage decreases as the solution is diluted and increases if the solution is concentrated again. To account for these results, it was suggested that the particles consist of short rods (400 A.) associated parallel to each other to form much longer aggregates, the number of rods in each aggregate being dependent on the concentration.

A paper on the properties of deoxyribonucleic acid prepared from the leucocytes of patients with lymphatic or myeloid leukæmia was read by Dr. E. E. Polli. Extensive investigations have shown that many of the physical properties of these preparations are similar to those of deoxyribonucleic acid from calf thymus but that the deoxyribonucleic acid from the leucocytes of myeloid leukæmia has an extra band in the infra-red spectrum and also shows some differences in behaviour on titration to acid *p*H. In addition, the deoxyribonucleoprotein from the myeloid leukæmia leucocytes was found to be 95 per cent dissociated in salt concentrations of 0·4–0·6 *M*, in contrast to the behaviour of calf thymus nucleoprotein and nucleoprotein from lymphatic leukæmia leucocytes which are only 5 per cent dissociated at these salt concentrations.

Further work on the physical properties of calf thymus deoxyribonucleic acid was reported by Prof. P. Doty. The examination of a series of samples of molecular weights from 8×10^6 to 3×10^5, produced by sonic degradation, has shown that $[\eta] \propto M^{1\cdot08}$ and $S_0 \propto M^{0\cdot37}$. Heat-denaturation studies in the presence of salt have shown that on the addition of hydrogen-bond-breaking agents such as urea or guanidine hydrochloride, the temperature at which a marked fall in viscosity occurs is reduced. The increase in the absorption at 260 mμ increases by as much as 32 per cent if the measurements are made at the temperature of the heating experiments; but on cooling the solution, the absorption falls to only 14 per cent greater than before heating. This change was attributed to the random formation of hydrogen bonds when the solution was cooled. It was also found that the denaturation process is not a first-order reaction, since not only does the rate of denaturation increase with temperature (above the denaturation temperature) but also the extent of the reaction increases. The correspondence between this process and the progressive melting of crystallites in a polymer was discussed. Dr. P. Alexander and Dr. K. A. Stacey dealt with the denaturation of herring sperm deoxyribonucleic acid by urea. At concentrations less than 0·003 per cent, the molecular weight is reduced by about one-half. Electron microscope photographs showing the disappearance of fibrils after treatment with urea at room temperature lend support to their suggestion that the twin strands of the helix are separated under these conditions. The effect of denaturation has been studied by Dr. A. R. Peacocke using titration techniques. These experiments showed that heating or sonic degradation disrupts the hydrogen bonds between the two pairs of bases at random, whereas degradation by γ-rays or by acid treatment produces a non-random rupture of the hydrogen bonds.

Further work on the analysis of the structure of deoxyribonucleic acid and nucleoprotein was described by Dr. M. F. H. Wilkins. Another contribution was made by Dr. H. Wyckoff, who showed that the reversible change from the *A*- to the *B*-form can be produced by varying the alcohol concentration of a solution between 75 and 90 per cent, and that in 90 per cent alcohol the *B*-form can be obtained from the *A*-form by stretching the filaments. X-ray diffraction studies on the synthetic ribonucleotides, polyadenylic and polyuridylic acid, were described by Dr. A. Rich, who showed that on mixing solutions

of these two polymers the molecules combine to give a twin-stranded helix. Further work on ribonucleic acid was reported by Dr. R. Franklin, who has compared the X-ray diffraction pattern of tobacco mosaic virus with that from the reconstituted protein. The results show that the ribonucleic acid of the virus lies 40 A. from the axis.

Dr. G. D. Hunter showed that the nucleic acids of *B. megaterium* can be obtained by treatment of the protoplasts with dodecyl sulphate and the ribo- and deoxyribo-nucleic acids separated by sedimentation. Some nucleic acid, mainly deoxyribonucleic acid, which is precipitated with the protein during treatment with the detergent, has been isolated by treatment with chloroform. This deoxyribonucleic acid differs in composition from that which dissolves on treatment with the detergent. Ribonucleic acid from a strain of the organism trained to grow on lactose has the power to induce β-galactosidase activity in an untrained strain in the absence of any other inducer. Dr. A. S. Jones and Dr. A. R. Peacocke reported the isolation of ribonucleic acid from *Aerobacter aerogenes* using sodium cholate as an enzyme inhibitor. Titration studies have shown significant differences between the forward and back titration curves in the acid and alkaline regions. This hysteresis implies the existence of hydrogen bonds on both the 6-amino and the 6-keto groups. Investigations of the composition of the ribonucleic acid in nucleoprotein preparations from a wide variety of organisms were described by Prof. E. Chargaff. In all cases the number of 6-amino groups has been found to be equal to the number of 6-keto groups to within a few per cent, although the ratio of purines to pyrimidines is in general significantly different from unity. Work on the proteins of the nucleoprotein complex was also reported.

New methods of fractionating deoxyribonucleic acid in nucleoprotein using polysulphates were described by Dr. M. Hickens, Dr. P. W. Kent and Dr. P. V. F. Ward. Dr. G. A. Gilbert commented on the use of electrophoresis measurements for studying the interaction between deoxyribonucleic acid and proteins, and showed how it is possible to obtain three peaks in the ascending boundary with these systems. The interaction of herring sperm deoxyribonucleic acid with amino-acids and peptides has been studied by Dr. R. Zahn, who has found that the reaction occurs in two stages: a relatively rapid reaction leading to an increase in solubility in alcohol, followed by a slower reaction in which the solubility is reduced.

Papers on the protein components of deoxyribonucleoproteins were read by Dr. P. F. Davison and Prof. K. Felix. Prof. Felix dealt with the fractionation of the protamines of herring sperm and reported results on the composition and molecular weight of the fractions. Further work on the composition of nucleoprotein of the testes of *Trutta fontinalis* at different stages of maturity has shown that nucleoprotamine appears about the mid-point of the ripening period and that its composition does not change after this stage. At all stages a second basic protein, probably a histone, is also present. These results suggest that the protamine is synthesized by a special process similar to that by which the proteohormones of the glands are formed. Dr. Davison discussed the histones obtained from nucleoprotein of ascites tumour cells. Of these preparations, 25 per cent or less is precipitated at *p*H 6·5; the properties of the remainder are found to be similar to those of histones from normal tissues. Fractionation and analysis of the material precipitated at *p*H 6·5 suggests that it is an aggregate formed from histones and a non-basic protein. There is some doubt whether this non-basic protein is a constituent of the nucleus. Photographs of the isolated nuclei show the presence of cytoplasmic contamination.

Recent work on the transforming principle of *Haemophilus influenzae* was reported by Prof. R. M. Herriott. Sedimentation and diffusion studies have given a preliminary molecular weight of 15×10^6. Investigation of the absorption mechanism using tracer techniques has shown that some of the absorbed deoxyribonucleic acid can be removed by washing or by the action of deoxyribonuclease. For every 1,000 molecules of deoxyribonucleic acid which are irreversibly absorbed, about eight cells are transformed. There is no evidence that the absorption process fractionates the transforming activity. Studies on *Haemophilus* inactivated by ultra-violet irradiation show no reactivation on exposure to visible light. If, however, a cell-free extract of *E. coli B* is added, 30–50 per cent of the original activity of the *Haemophilus* is restored.

Incorporation studies in *in vitro* systems were discussed by Mme. Y. Khouvine and by Prof. J. N. Davidson and Dr. R. Y. Thomson. Mme. Khouvine has investigated the incorporation of phosphorus-32 into the nucleic acids of cell fractions of an epithelioma of the rat under a variety of conditions, and has adduced evidence that the enzyme systems involved in the incorporation differ among the various cell fractions. Preferential incorporation into ribonucleic acid rather than deoxyribonucleic acid is found. Prof. Davidson demonstrated that the incorporation of carbon-14 formate into the nucleic acids of bone-marrow and ascites cells and a strain of mouse sarcoma cells growing *in vitro* occurs to a much greater extent into thymine than into the purines, suggesting that the nucleic acids are synthesized from preformed purines. The addition of a particle-free extract of mouse or pigeon liver results in an increase in the incorporation of carbon-14 formate into the purines, presumably by providing the enzyme system for purine synthesis. Studies on the incorporation of phosphorus-32 into the ribonucleic acid of rat liver were described by Dr. H. N. Munro. The incorporation is considerably lower in rats fasted overnight after a diet containing adequate protein than in rats maintained on protein-free diet. It was suggested that breakdown of ribonucleic acid occurs when the supply of amino-acids is stopped, and that the products dilute the isotopically labelled precursor pool. Feeding protein at the time of injection increases the uptake to that of the rats fed on the protein-free diet.

Investigations made by Dr. D. B. Dunn of the incorporation of some thymine analogues into the nucleic acids of a strain of *B. coli* suggest that there are possibly two routes for the incorporation into deoxyribonucleic acid. The growth inhibition of these analogues is ascribed to the formation of deoxyribonucleic acid in which many breaks occur in one strand of the helix, thus blocking further duplication. Further metabolism studies involving 8-azaguanine were reported by Dr. H. G. Mandel and Dr. R. Markham. The incorporation of the analogue into the ribonucleic acid of *Bacillus cereus* was demonstrated. Addition of guanylic acid to a culture inhibited by the analogue leads to an increase in growth-rate, the analogue being ejected from the bacterial cells as the nucleoside. K. V. SHOOTER

HYDRAULICS RESEARCH IN GREAT BRITAIN

WORK OF THE HYDRAULICS RESEARCH ORGANIZATION

By F. H. ALLEN
Assistant Director

THE Hydraulics Research Organization of the Department of Scientific and Industrial Research was brought into being in 1947 in order to undertake research into open-channel flow, and, in particular, into the manifold problems of loose-boundary hydraulics as these are met in rivers, estuaries and coastal waters. Since that time, the Organization has expanded steadily until it now has a staff of about 130 and occupies a 90-acre site at Howbery Park, near Wallingford, Berkshire. The director of the Hydraulics Research Station is Sir Claude Inglis, formerly director of the Indian Waterways Experimental Station at Poona. The Station resembles the other research establishments of the Department of Scientific and Industrial Research in that its programme is controlled by a board of eminent engineers and scientists serving in an honorary capacity.

During 1947–51 the new Organization worked in cramped and temporary quarters at the National Physical Laboratory, while the new research station was planned and constructed at Wallingford. The Organization was transferred to Wallingford from 1951 and has been operating there in full strength since the summer of 1952. The nineteenth-century Manor House of Howbery Park has been converted for use as offices, and also includes the library, drawing office and canteen. In the first years at Wallingford, much of the work was carried out on the open-air research facilities, which were available long before the main covered accommodation which is now the nucleus of the Station. These open-air facilities include two large wave basins, each measuring 80 ft. by 125 ft. and equipped with permanent wave-generating machinery, and a pair of unusually long experimental flumes or channels of rectangular cross-section, one 5 ft. and the other 12 ft. in width and both approximately 350 ft. in length. The wave basins are used for model investigations of harbours and for loose-boundary studies of the formation, development and protection of beaches. The channels are devoted to basic research into factors affecting the regime shapes and slopes of alluvial channels. For some time from 1952 it was also necessary to make use of existing temporary accommodation in the form of small precast concrete sheds. A valuable wave tank, 10 ft. wide and 54 ft. long, was constructed in one of these buildings and has since been used for a variety of investigations, including studies of the stability of various breakwater sections and experiments to determine how the rate at which water particles drift in the presence of waves varies with depth. Certain small models and experimental flumes were also built in temporary sheds at this period.

The major part of the permanent experimental accommodation of the Station became available for use only in January 1955. The Main Hall as it now stands measures 300 ft. by 200 ft., and the interior is unobstructed except for two columns supporting the roof. The ceiling is about 25 ft. above floor-level. This impressive building is known as Stage 1 of the Main Hall, and major extensions to it are planned for erection in further stages during the next decade, the overall length of the final structure being 700 ft. The Main Hall has a radiant heating system and ample supplies of water, electrical power and artificial light; it has provision for water storage and drainage below floor-level and photographic facilities at ceiling-level. Transporter gantries are also suspended from rails at ceiling height. The floor consists of consolidated earth, loosely stabilized with a cold bitumastic emulsion, and may be excavated as required for the construction of hydraulic models. As accommodation for hydraulic research, the building has won the admiration of many home and overseas visitors, and the facilities it provides in this respect are undoubtedly second to none in quality and flexibility. Attached to the Main Hall is a subsidiary block in which the various workshops and smaller general-purpose laboratories (for mechanization, development of instruments, analysis of sediments and photographic processing) are housed.

In addition to basic or background research on open-channel flow and wave action, the Station carries out a considerable amount of *ad hoc* or applied research—indeed, at the present time, about three-quarters of the total effort of the establishment is devoted to applied research on specific problems of one kind or another. Typical objectives of these investigations are the dissipation of turbulence below falls, sluices and similar hydraulic structures, the prevention or reduction of flooding, the improvement of shipping channels in ports and estuaries by the control or reduction of siltation, the damping of waves entering harbour and river mouths, and the control or retardation of coast erosion by wave action and tidal currents. These studies are carried out—usually on a repayment basis—on behalf of government departments, river boards, port authorities, coastal protection and local authorities, consulting engineers and private individuals. Work is also carried out for overseas members of the Commonwealth and for certain foreign countries.

The laws of similitude as applied to hydraulic models are sufficiently well known to need no detailed exposition. It is sufficient to say that, as gravitational forces predominate in most of the problems with which the Station is concerned, the Froude law is of over-riding importance in experimental work with scale models. In the study of problems involving the scour, transport and deposition of channel-bed material, movable-bed models—moulded in sand, pumice or some such incoherent granular substance —are used. The limitations of similitude in such models are recognized, and have indeed been the subject of controversy; but it is now well established that they are invaluable aids in the solution of complex problems of bed movement and siltation. The similitude which can be demonstrated to exist in movable-bed models has not yet been fully defined

by a mathematical analysis, and experimental work on models of this type can therefore be described with some justice as being partly an art and partly a science. Certainly it is a field of work where wide experience is essential, and where results must be subjected to continual scrutiny and comparison with the known behaviour of the natural prototypes.

The concept of regime, first developed on an empirical basis from a study of canals in India, has been found to be of wide application in the field of loose-boundary hydraulics and is itself the subject of basic research at the Station. In its application to uni-directional flow in alluvial channels—an aspect of the subject which is receiving an increasing amount of attention in the United States—regime theory relates the width and depth of a channel to the water discharge, the slope of the water surface and the quantity and nature of material in movement on the bed and in suspension. The application of this theory to hydraulic models is in itself an obvious subject for research.

There would be little point in listing all the investigations now in progress at Wallingford, but some idea of the scope of the research programme may be given if a few of the major projects are singled out for mention. Thus in the realm of tidal flow in estuaries, two major investigations of siltation are in progress—one concerning the deterioration of the upper estuary of the Mersey, and the other being aimed at the stabilization and deepening of the shipping channel at and below the port of Chittagong on the Karnafuli River in East Pakistan. A tidal study of a different type is in progress in a rigid-bed model of the tidal Trent, where methods of protection against combinations of river and tidal flooding are being tested. A large proportion of the Station's effort is devoted to studies of wave action. In one of the wave basins a large model of the proposed design for the new harbour to be built at Tema, on the Gold Coast, is being examined to determine its behaviour under the influence of short-period and long-period waves. A model of a new sea wall for the Lincolnshire bank of the outer Humber is being subjected to two-dimensional tests in the 54-ft. wave tank. The formation of a sand-bar across the entrance to Eyemouth Harbour in Berwickshire is being studied in a 1/40-scale model equipped with pneumatic wave generators. Investigations of river problems and hydraulic structures also figure largely in the Station's programme of applied research and experimentation. In conclusion, mention should be made of radioactive isotopes as tracers for indicating the movements of silt and sand, in the use of which the Hydraulics Research Station, in collaboration with the Atomic Energy Research Establishment at Harwell, has carried out valuable pioneering work.

OBITUARIES

Mr. John Evershed, C.I.E., F.R.S.

By the death on November 17 at the age of ninety-two of John Evershed, we have lost the *doyen* of British astronomers. Born on February 26, 1864, at Gomshall in Surrey, he was educated privately and started to work in the chemical industry. He early developed an interest in astronomy and established his own observatory at Kenley in Surrey in 1890. In that year he became one of the founder members of the British Astronomical Association and director of the Section of Solar Spectroscopy. With a small telescope and a spectroscope of his own design and construction, and later with a spectroheliograph also built by himself, he recorded 11,000 solar prominences during his sixteen years work at Kenley. The Evershed solar spectroscope is still an instrument in use to-day.

In 1906 he was appointed assistant director of the Kodaikanal Observatory; in 1911 he succeeded Michie Smith as director, retiring to England in 1923, when he was created C.I.E. in recognition of his work in India. At Kodaikanal he continued his work on prominences and with Mrs. Evershed he published an important memoir on the distribution of prominences during the course of a solar cycle: they noted the excess of eastern over western prominences, the longward displacement of the lines in their spectra and the link between sunspots and metallic prominences. Evershed also greatly improved the quality of the spectroheliograms obtained at the Observatory. His work on sunspot spectra led to his best-known discovery, the radial motion of gases, outwards across the penumbra of a sunspot and inwards at higher levels in the solar atmosphere. This work, published in 1909, led to his election to the Royal Society in 1915 and to the award of the Gold Medal of the Royal Astronomical Society in 1918.

Other work carried out by Evershed at Kodaikanal included studies of solar rotation, of the spectra of comets, Venus and Nova Aquilæ 1918, of the displacement of lines to the red at the centre and limb of the Sun. He also chose a site for the Cawthron Observatory in New Zealand and travelled to the Vale of Kashmir to find a site with first-class seeing for a solar observatory in India. He observed eclipses in Norway, 1896; India, 1898; Algeria, 1900; Spain, 1905; Australia, 1922; and Yorkshire, 1927. Among his eclipse results were the first record of the chromospheric continuous spectrum at the head of the Balmer series and his successful securing of long exposures on the chromosphere by stationing himself close to the edge of the belt of totality.

On his return from India, Evershed settled at Ewhurst in Surrey, where he built himself an observatory for solar work, continuing to obtain high-class spectroheliograms and high-dispersion solar spectra. His chief point of interest lay in exact wave-lengths of lines in the spectra of prominences and of the centre and limb of the solar disk. In a series of papers, giving measures of the highest degree of accuracy and continuing until the year 1949, he discussed the varying displacements of lines to the red. He reached the final conclusion that the Einstein gravitational effect was the main cause of the displacements, though the result was modified by Doppler and Lindholm effects. He also examined some Mount Wilson plates that had been used to determine the general magnetic field of the Sun and concluded that the observed slight displacements were due to localized Doppler effects.

The last published report of the work of his observatory was for the year 1950. On closing it down finally, he presented some of his instruments to the Royal Greenwich Observatory at Herstmonceux.

Evershed married in 1906 Miss Mary Acworth, and she collaborated actively with him in his researches until her death in 1949. He was married a second time in 1950, to Miss Margaret Randall, who survives him. F. J. M. Stratton

Dr. A. J. Carlson

When he died on September 2, Dr. Anton Julius Carlson bore the illustrious title of "Frank P. Hixon distinguished service professor emeritus of physiology, University of Chicago".

Carlson was born in Sweden in 1875 and went to the United States in 1891. He graduated A.B. at Augustana College, Rock Island, Illinois, in 1898, A.M. the following year, and Ph.D. in physiology at Stanford University in 1903. After spending one year as a research associate at the Carnegie Institution, he joined the Department of Physiology of the University of Chicago in 1904 and remained there until he retired in 1940 from the positions of professor and chairman of the Department. As professor emeritus he continued actively at work, and himself told a Committee of the House of Representatives in 1950 that "for the last ten years I have been emeritus or demeritus, whatever you call it; however, the only thing I retired from ten years ago was my salary". In the U.S. Army during 1917–19 he was a lieutenant-colonel in the Sanitary Corps, and while serving in Sweden was given the honorary degree of M.D. by Lund. He held honorary degrees from seven universities.

Carlson's early work was on the rate of conduction of impulses in nerves and, after some excursions into the comparative physiology of the circulation, he did his main work upon the physiology of the alimentary tract and of the visceral sensory nervous system. Apart from some two hundred papers, he wrote two books: "Control of Hunger in Health and Disease" and "The Machinery of the Body".

Carlson was honoured by many institutions. He was elected to the U.S. National Academy of Sciences in 1918, to the American Physiological Society in 1904 (being secretary during 1910–14 and president 1923–25), and to a variety of others in the United States and abroad. He had also served as president of the American Association for the Advancement of Science, the American Biological Society, the Federation of American Societies for Experimental Biology, the Institute of Medicine, the American Association of University Professors, and the National Society for Medical Research. In 1935 he lectured in China under the auspices of the Rockefeller Foundation, and he was a frequent traveller, attending seven international physiological congresses between 1909 and 1950, and the international gerontological congress in London last year.

Carlson was a great teacher, and himself said that he had taught between 8,000 and 10,000 medical students, and 75,000–100,000 other students. He was forthright, very outspoken and a keen controversialist. His work as a consultant on Government organizations (such as the Food and Drug Administration and the Office of Scientific Research and Development) often enlivened meetings; but surprising though his statements sometimes appeared, they were always backed by experimental facts, often elicited in his own laboratory. H. M. Sinclair

NEWS and VIEWS

Hungary: American Scientists' Resolutions

The U.S. National Academy of Sciences at its autumn meeting in Washington adopted the following resolution respecting recent events in Hungary: "Those members of the National Academy of Sciences of the United States of America present at a meeting in Washington on November 10, 1956, unite in expressing their profound admiration and sympathy to fellow scientists in Hungary and to all the men and women of that nation who have demonstrated their love of liberty with sacrificial devotion during the tragic events of the past few weeks. American scientists look forward with hope to a time when their Hungarian colleagues, freed from external oppression, will be able to join fully in the international exchange of information, discussion and encouragement which is essential to the progress of science". Dr. Detlev W. Bronk, president of the Academy, expressed his satisfaction that the Academy's resolution could be associated with a similar statement adopted by the American Philosophical Society. "It is appropriate," he said, "that the Academy should join with the American Philosophical Society, the oldest of the great scholarly societies of the United States, in a matter so closely related to the unconquerable yearning of mankind freely and courageously to advance its highest human and cultural ideals. The statements of the Academy and of the Society recognize with humility and deep gratitude the desperate and courageous struggle of Hungarians for those principles which are precious to all who value the right to seek truth and to teach it freely."

Institute of Metals: Awards

The Institute of Metals have made the following awards: *Institute of Metals* (*Platinum*) *Medal for* 1957: Dr. Maurice Cook, joint managing director, Imperial Chemical Industries, Ltd., Metals Division, in recognition of his outstanding contribution to the science of metallurgy, to the non-ferrous metals industry and to the welfare of the metallurgical profession; *Rosenhain Medal for* 1957: Dr. H. K. Hardy, research manager, United Kingdom Atomic Energy Authority, Industrial Group, in recognition of his outstanding contributions to knowledge in the field of physical metallurgy.

University of Leeds Appeal

Immediately before the War the number of full-time students at the University of Leeds was about 1,750. The number has now increased to 3,700 and, among these, the number reading science or technology has grown from 560 to 1,700. In five or six years time it is expected that there will be 5,300 students in all, of whom 3,000 will be reading science or technology. During the past sixteen years the research work of the University has developed at a rapid rate and will develop even more quickly in the next five or six years. To meet these demands, the

University has embarked on a building programme which must be completed in the next five or six years and will cost, in all, about £6,000,000. Most of this money will almost certainly come from the Government which, on the advice of the University Grants Committee, has selected Leeds as one of four universities outside London for 'major developments' in the field of scientific and technological education. The Government has made it clear, however, that it has chosen to help the University of Leeds largely because it believes that Leeds can continue to count on help from other sources; for at least £600,000 of the total needs the University has to look to industry and commerce and to private benefactors. Already £200,000 of this sum has been assured by gifts and promises. The Vice-Chancellor has now issued an appeal to many firms to help the University in its development work. There is little doubt that the appeal will be successful.

Rotherham College of Technology

To mark the twenty-fifth anniversary of the opening of the main building of the Rotherham College of Technology, a Jubilee Foundation Lecture was delivered on November 6 by Mr. R. F. Jackson, operations group leader in the Reactor Division of the Atomic Energy Research Establishment at Harwell, on "Research Reactors in the Nuclear Power Programme". During the quarter of a century since its foundation the Rotherham College of Technology has made a valuable contribution to industry in the Rotherham and Sheffield area. In carrying out extensive pioneer work in technical education it has established a high reputation, both locally and nationally; and during the past four years it has become the regional centre for south Yorkshire for powder metallurgy, furnace brickwork and for sandwich courses in mechanical and electrical engineering.

Clinica Chimica Acta

THE newer biochemical techniques, in particular improved methods of separation, such as chromatography and electrophoresis, and the use of isotopic tracers, are opening endless avenues for exploration by those engaged in medical research. As a result, papers on clinical biochemistry are appearing in ever-increasing numbers. These papers are now spread among a wide variety of journals and are often regarded as too clinical by the pure biochemist and as too biochemical by the pure clinician. As a result, in several countries journals have been, or are being, initiated to cater for clinical biochemistry as a scientific discipline in its own right. Messrs. Elsevier have given substance to hopes expressed at the first International Congress on Clinical Chemistry, held in Amsterdam in September 1954, that there should be started an international journal in this field. The new journal is a commercial venture, not attached to any scientific society, and the publishers have been able to assemble an editorial board and an advisory board impressive in their high standing, and carrying assurance of a sound editorial policy (Elsevier Publishing Co., Ltd., Amsterdam, London, Houston, New York. Six issues per year, of approximately 100 pages each. £4 10*s.* per volume of 6 issues). The international flavour is shown both by the composition of the editorial board (the fourteen members of which represent eleven countries) and by the authorship of the thirty-one papers in the first three issues, contributed from ten countries. A very desirable, but probably rather expensive, feature is that summaries of all papers are given in four languages—English, French, German and Russian. This should encourage one of the subsidiary hopes of its founders, namely, that the journal will promote some degree of standardization in biochemical procedures applied to medicine, and thereby facilitate mutual interpretation of results. The format and standard of production are of the high quality which one has learnt to associate with Elsevier publications. The price, as seems almost inevitable nowadays, makes the journal more likely to be taken by libraries than by individuals. If a high editorial standard is maintained, this journal is likely to come to be considered of prime importance in all institutions concerned with clinical biochemistry.

Midwest Research Institute, Kansas City: Annual Report

THE annual report of the Midwest Research Institute, Kansas City, Mo. (pp. 16; 1956), presented by the president, Dr. C. N. Kimball, to the Trustees at their eleventh annual meeting on May 14, records a 20 per cent increase in the amount of contract research, which amounted to 2,170,000 dollars in value on 503 different projects for 208 sponsors. Of the Institute's full-time staff, 175 are professional research workers and more than half the work was based on ideas originating with the Institute's own staff. Among projects noted by Dr. Kimball are the work on air pollution in Los Angeles, now in its third year, involving the determination of the effect of materials emanating from automobile exhausts; the development of industrial products, such as polymers from non-edible tallows and greases; and the design of an electromechanical device which, in a relatively small space, simulates operating conditions in an oil-well with respect to the performance of its components. In the field of automation, methods and equipment have been developed for checking practical horse-power motors to meet the requirements of the National Electrical Manufacturers Association, and among the projects on which the eleven people engaged in marketing research have been occupied is an analysis of factors affecting the market potential for anhydrous ammonia as fertilizer. Those engaged in operations research have made a study of the possibility of setting up a mathematical model which would govern inventory policy. Work has been done on the addition of chemicals to food prior to irradiation, and a group of people with extensive experience in the field of nuclear energy is being formed. Projects bearing directly on public health or wealth included broad studies of the basic economy of the Great Plains Area; methods of transmitting to the mind of the blind person information about objects beyond his reach; and the development of an artificial lung and heart to permit operations on the human heart itself. Dr. Kimball believes that in future the production of new technology will become a competitive business activity, and he also stresses the importance of new materials and techniques.

Pacific Science Board: Report for 1954

THE eighth annual report of the Pacific Science Board for 1954 (pp. 61. Washington, D.C.: National Academy of Sciences—National Research Council, 1955) summarizes the progress made in studying the environmental factors affecting life on coral atolls, which has been the chief activity of the programme

of the scientific investigations in Micronesia. Vegetation and soil distribution and character for thirty-three islets at Kapingamarangi in the Southern Carolines were plotted by the geographer and land ecologist, and the general ecological relations between climate, vegetation, soil character, current and wave effects were plotted on the maps as "land use formulæ" for later analyses. The total fish fauna was intensively studied, as well as the present and potential fisheries. The programme also seeks to develop criteria for estimating the carrying capacity of an atoll. The Invertebrate Consultants Committee for the Pacific continued its investigation as to whether *Gonaxis kibweziensis* snails effectively control the *Achatina fulica* snails on the island of Agiguan, and completed work on the identification of various scientific collections of importance to the ecological study of Pacific atolls. Scientific investigations in the Ryukyu Islands was limited to the preparation of reports and the completion of the nine-month study of cultural changes in Okinawa resulting from the United States military occupation. E. H. Walker's report on important trees of the Ryukyu Islands was published by the Civil Administration of the Islands. Approved field projects included studies of social and economic life in the Society Islands; of law in a primitive society in the Netherlands New Guinea; of mosquitoes in the South Pacific area; and a preliminary study of social aspects of depopulation among the Murits of British North Borneo. Among the matters discussed by the Conservation Committee for Micronesia were the extension of the season for collecting the shells of *Trochus niloticus*, the proposed Palau reserve, forestry practice in the Trust Territory, the introduction of bamboo and implications of the possible release of carrion crows and land snails on islands other than Agiguan. Details are given of Fulbright awards during 1954–55 for research or lecturing in Pacific and East Asian countries.

An Expedition to Papua

A summary of the results obtained by the fourth Archbold Expedition to New Guinea (1953)—in fact to E. Papua and adjacent islands—under the editorship of L. J. Brass has now appeared as a bulletin of the American Museum of Natural History (**3**, 2, 83–152; 1956). The summary report gives brief accounts of the physiography, geology and climate of the regions surveyed, together with notes on the economy of the native peoples, previous expeditions and collections and major plant communities. In conformity with previous expeditions of the Archbold series, the main purpose was the collection of biological materials and ecological and distributional studies of mammals, reptiles, amphibians, freshwater fishes, insects, spiders and plants. As the avian fauna of the region was considered to be fairly well known, less attention was given to the collection of birds. Ectoparasites of mammals and soils for screening for antibiotic-producing micro-organisms were also collected. In terms of these materials, the results of the expedition included the following collections: mammals, 1,954; birds, 91; reptiles and amphibians, 1,645; freshwater fishes, 145; insects and spiders, 80,000; ectoparasites of mammals, 750; materials for antibiotic research, 126; plants, 3,445; anthropological items, 34.

Macrolithic Culture of Florisbad, South Africa

The explorations at the fossil springs at Florisbad in the central province of the Union of South Africa will be always associated with the name of the late Prof. T. F. Dreyer, who described the rich archæological material from the site and had the good fortune to discover the Florisbad skull. A paper on the "Macrolithic Culture of Florisbad" (*Res. Nat. Mus., Bloemfontein*, **1**, Part 9, 205; 1956) was in the course of preparation by Prof. Dreyer when he died, and we owe its completion to Prof. A. J. D. Meiring. At the site there are four peats, and while the tools in the upper three are mostly made from lydianite, those from Peat I and below are almost entirely fashioned from dolerite. This early industry may well be considered, then, as a distinct culture from those which occur later on. While carbon-14 dating of the peats, frankly, has not been too satisfactory, it is clear that Peat I was laid down a very long time ago, somewhere about 35,000–40,000 years before our era. The industry here described is very coarse and such as one might expect to be made from pieces of dolerite. There are choppers, coarse points and what Meiring describes as pyramids. One or two specimens can perhaps be termed proto-hand axes; but these rough chopping and pounding tools fall into no very definite category of industry. Some of the dolerite tools were found by Prof. Dreyer in close association with the human skull fragments. Florisbad is an interesting and puzzling site. It cannot be said that we yet have enough knowledge of South African prehistory to fit it exactly into the prehistoric story.

Forestry Commission: Report for 1954–55

In the Forestry Commission's report on forest research for the year ended March 1955 (pp. 140+12 plates. London: H.M.S.O., 1956; 5*s*. 6*d*. net), it is stated in the introduction that changes are taking place owing to the fact that problems of establishing forests are now becoming less prominent while those of maintenance, protection, management and utilization are becoming more important—an experience which every country taking up forestry seriously has been through. As regards research, there still remain several types of land on which research must be prosecuted to obtain an assurance that successful crops will be attainable. An example is the poor *Scirpus* peats of the north and north-west of Scotland. Experiments have achieved success, where the exposure is not too severe, with intensive cultivation; but more research remains to be done, which is being undertaken with the help of the Macaulay Institute of Soil Research, Aberdeen. Another type of land which has received much recent attention is the ground which lies above the Commission's present planting elevation. Here the current problem is to find out whether it is possible to plant higher and at the same time to obtain a satisfactory yield return. There are very considerable areas of this type of land available for possible treatment. A soils section has been formed at Alice Holt Research Station to carry out routine investigations in conjunction with other sections undertaking this type of work. A summary of the year's work is given by M. V. Laurie, who deals with nursery work, pilot plots for afforestation purposes, ecology, genetics, pathology and entomology and grey squirrels, with a very interesting summary of machinery research that shows the remarkable advances made under the direction of the Forestry Commission. The investigations on mycorrhiza which were commenced at Bedford College, London, are being continued. In other respects the report is on the lines of previous ones.

Fixation of Atmospheric Nitrogen by *Hippophaë rhamnoides* L.

G. Bond and J. T. MacDonnell (*Ann. Bot.*, **20**, 79, 501; 1956) have shown that when *Hippophaë* plants were inoculated at the six-leaf stage with a suspension of crushed nodules, they began to develop nodules in about two weeks and soon afterwards were able to grow satisfactorily in culture solution free of combined nitrogen. Some 79 mgm. nitrogen per plant was accumulated during seven months of active growth. They conclude that the nodules fix atmospheric nitrogen, and that in its nitrogen nutrition the *Hippophaë* plant shows a close similarity to the nodulated legume. They point out that *Hippophaë* and the other angiosperms with nitrogen-fixing root nodules are all woody species or belong to a family which includes woody types. They also make the interesting suggestion that the physiological property under consideration is a very ancient character and may go back to a period when only woody plants existed. In a further study, G. Bond has found that field nodules of alder, like those of plants grown in the greenhouse, regularly fix nitrogen (*New Phytol.*, 55, 2, 147; 1956).

Scintillation of Starlight

A PAPER by A. H. Mikesell on "The Scintillation of Starlight" (Pub. U.S. Naval Obs., Series 2, **17**, Part 4, 143; 1955) describes the results of the observations of scintillation since 1950. The two main objects of the investigations were to measure its effects on the accuracy of stellar photometry and to locate the underlying meteorological causes of the phenomena; and a very full description is given in the paper of the equipment, reduction of observations, discussion of the results, etc., with numerous diagrams. It was found that harmonic components of scintillation decreased with frequency approximately uniformly from 0·1 c./s. to about 500 c./s. Many combinations of telescopes and photoelectric photometers were used, and it was found that the form of the optical equipment was unimportant so long as the objective aperture was circular and all incident light reached the photo-tube. Seasonal variations in scintillation plotted against different frequencies gave the largest values at high frequencies. There was a correlation between scintillation and the maximum speed of winds aloft, especially with winds at altitudes of 8–16 km., but at levels much lower than this region the correlation was not so obvious. At frequencies higher than 150 c./s. the action of the wind was most striking, and on thirty-eight nights when scintillation was observed at frequencies greater than 550 c./s. the maximum reported speed aloft was always greater than 85 m.p.h.; on sixty-two other nights when scintillation appeared only at frequencies less than 550 c./s. the maximum wind-speed exceeded 85 m.p.h. fewer than ten times, and the average maximum speed was 72 m.p.h. with a standard deviation of 23 m.p.h. Detailed examination of the distributions of winds or temperatures on each of the hundred nights of observations showed that there was no correlation of scintillation with a common weather characteristic, such as wind shear, wind direction, location of wind maximum or minimum, intermediate temperature inversion, location or minimum value of the stratospheric temperature, or temperature lapse-rate. The variation of scintillation with zenith distance z of the light source was found to be sensitive to frequency; while scintillation is constant at about 100 c./s., below or above this frequency it changes greatly with z, a fact which encourages the use of Polaris as a scintillation source in routine observations. Although there is some correlation between scintillation and seeing, more extensive observations and more definitive criteria of seeing are necessary before accurate assessment of the correlation can be made.

Smuts Collection of the Transvaal Museum, Pretoria

IN Bulletin No. 2 of the Transvaal Museum, Pretoria, it is stated that the Smuts collection has, with the consent of the Minister of Education, Arts and Science, been deposited by the Union Archives in the Transvaal Museum. The collection comprises a wealth of items belonging to the late J. C. Smuts and include his field-marshal's baton, medals and decorations, numerous freedoms of cities and other presentations, together with many personal items.

Announcements

PROF. W. T. ASTBURY, professor of biomolecular structure, University of Leeds, has been elected a foreign member of the Swedish Royal Academy of Sciences.

DR. D. S. DANE has been appointed lecturer in microbiology in The Queen's University of Belfast.

DR. G. R. HARRISON, dean of science at the Massachusetts Institute of Technology, has been awarded the first Pittsburgh Spectroscopy Award, which has been established by the Spectroscopy Society of Pittsburgh in recognition of distinguished contributions to this field of science. Among Dean Harrison's outstanding achievements are his numerous studies of line spectra, the measurements and compilations for the "M.I.T. Table of Wavelengths" and important contributions to the ruling of gratings; for ten years he has been editor of the *Journal of the Optical Society of America*.

THE Council of the Gesellschaft Deutscher Naturforscher und Ärzte has decided to establish from time to time a competition to direct attention to certain problems, in natural science and medicine, which call for special discussion, and a prize of D.M. 7,000 has been allocated this year for treatises on "The Formation of Stars by Condensation of Diffuse Matter". Entries may be in English, French or German and should be submitted by April 30, 1958, to the Hamburger Sternwarte, Hamburg-Bergedorf, Gojenbergsweg 112, from which further information can be obtained.

THE fifth International Congress of the International Association on Quaternary Research will be inaugurated at Madrid on September 30 and closed at Barcelona on October 3, 1957. Meetings will comprise sessions dealing with a wide range of subjects bearing on Quaternary geological studies. There will be excursions centred on both cities and into the country between them, to study Quaternary geology and Palæolithic sites. Further information can be obtained from Señor L. Solé Sabaris, Instituto Geological, Universidad, Barcelona, Spain.

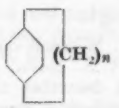
ERRATUM. The title of the communication by Dr. Winifred M. Watkins and Prof. W. T. J. Morgan in *Nature* of December 8, p. 1289, is incorrect; it should read, "Role of O-β-D-Galactopyranosyl-(1 → 4)-*N*-acetyl-D-glucosamine as Inhibitor of the Precipitation of Blood Group Substances by Anti-Type XIV Pneumococcus Serum".

HIGH-RESOLUTION NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY

HIGH-RESOLUTION nuclear magnetic resonance spectroscopy is a rather recent addition to the arsenal of the physical chemist. It has undergone a very rapid development during the past two years, due in large measure to the fact that nuclear-resonance spectrometers with a high degree of field stability are now commercially available. The term 'high-resolution' is generally used for nuclear-resonance measurements of liquid samples under conditions of magnetic-field homogeneity which permit resolution of the signals of non-equivalent nucleii in a given compound and also the fine-structure components arising from spin–spin coupling. The broad resonance signals characteristic of solids, on the other hand, are frequently termed 'broad-line' spectra. There is now ample evidence that the high-resolution nuclear-resonance technique is a very powerful one, and sufficient understanding of the basic phenomena has been gained to demonstrate its advantages as well as some of its limitations.

The basic problem in high-resolution nuclear magnetic resonance work is that of relating the various magnetic effects of the molecule which are measured to the more familiar notions of the chemist regarding electronic structure and molecular configuration. This problem was the central topic of discussion at an informal symposium held during September 6 and 7 at the National Research Council Laboratories in Ottawa. A detailed theoretical treatment of the chemical shift was discussed by Dr. J. A. Pople (Cambridge). The chemical shifts observed can be conveniently discussed in terms of circulating electron currents within the molecule which are induced by the magnetic field. These currents can be classified into three types according to their origin. First, there is the diamagnetic circulation about individual atoms of the molecule corresponding to the well-known Lamb shielding term. This type of magnetic shielding for a given nucleus can frequently be correlated with the electronegativity of neighbouring atoms in the molecule. A second type of circulation may occur in molecules where the nucleus under consideration is bonded to an atom with an electron structure which permits mixing of the ground-state with excited states, so as to give rise to an anisotropic magnetic permeability. It can be shown that this effect will dominate in certain cases where mixing involves transitions between *s*- and *p*-functions or between two *p*-functions. The simple hydrides ammonia, water and hydrogen fluoride are examples of the former, and acetylene of the latter. The chemical shifts of these molecules are anomalous. Dr. W. G. Schneider (Ottawa) reported that the chemical shifts of ammonia, water, hydrogen fluoride and hydrogen chloride, when in the free or unassociated state, lie on the high-field side of the proton signal in saturated hydrocarbons and do not differ markedly from each other. These results cannot be explained on the basis of electronegativity considerations but are readily interpreted in terms of the theory. On association (hydrogen bonding), the proton signals of these hydrides shift to lower field, the shift for hydrogen fluoride being very large, of the order of 8–9 parts per million.

A third type of circulating current is peculiar to aromatic molecules and arises from the circulation of the mobile π-electrons in a magnetic field. As a result, the proton signal of benzene will occur at lower applied field than that of ethylene. The theory provides a rather satisfactory interpretation of the observed chemical shifts of the protons of aromatic hydrocarbons. Further refinements of the theory were discussed by Dr. J. S. Waugh (Massachusetts Institute of Technology), as well as a very interesting experimental confirmation. When a proton is not in the plane of the aromatic ring as in benzene, but out of plane in the vicinity of the hexagonal axis, the chemical shift should be in the opposite direction, that is, to the high-field side of ethylene. This was confirmed by observing the relative proton shifts in compounds of the type :



Several other contributors had also independently observed proton shifts to higher field which can be satisfactorily explained by aromatic ring effects. Dr. A. Bothner-By (Harvard) reported an anomalous shift to high field of the chloroform proton in benzene solution. As a result of complex formation between chloroform and benzene, the chloroform proton signal is modified (shifted to higher field) by the ring current in benzene. This problem was also investigated in greater detail by Dr. L. W. Reeves (Ottawa), who showed that this anomalous shift in chloroform can be observed with benzene, toluene and mesitylene, which complex with chloroform, but not with nitrobenzene or *o*-dichlorobenzene. Dr. J. R. Zimmerman (Magnolia Petroleum Company, Dallas) reported that the proton signal of benzene itself shifts on dilution with hexane ; this can be attributed to a preferred mutual orientation of benzene molecules causing a modification of the proton signal by the ring effect. In a dilute solution of benzene this effect will be absent.

The large chemical shifts accompanying hydrogen bonding and association were discussed by several contributors. Dr. C. Reid (University of British Columbia) found that on successive dilution of ethanol with carbon tetrachloride the proton signal of the O—H group, which in pure alcohol is shifted about 5·5 parts per million on the low-field side of the methyl group, moves to high field, until in very dilute solution it appears on the high-field side of the methyl signal. The N—H proton signal in amines shows a similar behaviour. These large shifts of the proton signal accompanying hydrogen bonding are not yet understood. Dr. Zimmerman described a careful and detailed study of alcohol–water solutions. A plot of the chemical shift of the OH proton signal (measured relative to the alcohol methyl signal) against concentration exhibits a discontinuity. Some alcohols give rise to more than one such discontinuity. The corre-

lation time for proton exchange between water and ethanol was found to be of the order of 15 msec. Mr. A. Van Steenbergen (McGill) has studied the chemical shifts accompanying association of a number of alcohols, and the corresponding deuterated alcohols, as a function of temperature, by means of the spin-echo technique.

Nuclear resonance techniques have been very successfully applied by Dr. W. D. Phillips and his associates (Dupont Company, Wilmington, Delaware) to the problem of hindered internal rotation and *cis-trans* isomerism. Fluorine signals in halogenated ethane derivatives as well as proton signals in substituted nitrosamines were found to be double. At higher temperatures these coalesced to a single line. Assignment of the signals to individual isomers could be made. Dr. Phillips also discussed several examples of fluorine exchange in halogen fluorides. The spectrum of ClF_3, for example, which is sharp at $-60°$ C. but becomes broad at room temperature, can be accounted for by fluorine exchange, involving an activation energy of about 6 kcal.

Dr. P. C. Lauterbur (Mellon Institute, Pittsburgh) has been able to observe for the first time nuclear resonance signals of carbon-13 in natural abundance in a variety of organic and inorganic compounds. The resonances were observed in the dispersion mode at a fixed frequency of 8·5 mc./sec. and a field of about 7,940 gauss. Large variations in the chemical shift were found in the compounds measured, and the spin–spin coupling constant was found to be large (120–270 c./s.). The measurement of carbon nuclear resonances appears to be a very promising future development in the chemical field.

Considerable progress has been made in the problem of understanding and analysing the multiplet structure of high-resolution nuclear magnetic resonance spectra due to spin–spin coupling of the nuclei in a given molecule. The theory of multiplet splitting was outlined by Dr. J. A. Pople, as well as a detailed analysis of the interesting cases which arise when the J-coupling constant is of the same order of magnitude as the chemical shift, δ. Dr. H. J. Bernstein (Ottawa) discussed a number of observed spectra in which these conditions are met and which can be broken down into characteristic spectra of groups of two, three and four interacting nuclei. Analysis of the spectra gave excellent agreement with the theory. Although the meaning of the J-coupling constants in terms of electronic structure is as yet not understood, the values of these constants show significant differences in different classes of compounds.

Chloride ion resonances of chloride salts have been studied by Dr. J. E. Wertz (Minnesota). Large variations in line-width were observed. For example, addition of zinc chloride to aqueous sodium chloride broadens the chloride ion resonance. This is explained by interaction of the zinc ion with the chloride ion, which destroys the spherical charge distribution of the latter, resulting in quadrupole broadening of the resonance line.

The experimental problem of obtaining reliable chemical shift data has been extensively investigated by Dr. Zimmerman. Errors due to sample shape and to the use of internal reference standards were considered. It was recommended that external reference standards be used in connexion with a coaxial sample tube made from precision tubing. Dr. Bothner-By has made a thorough study of the effect of bulk magnetic susceptibility of the sample on the measured chemical shift. The effect, measured directly for a large series of aliphatic compounds and binary solutions, was found to be about 26 per cent greater than that calculated theoretically. With aromatic compounds there is a further anomalous behaviour which can be satisfactorily accounted for in terms of the induced 'ring' current mentioned earlier.

H. J. Bernstein
W. G. Schneider

INTERNATIONAL GENETICS SYMPOSIA IN JAPAN

During September 6–12 the Science Council of Japan was host to two International Genetics Symposia: one on "Applied Genetics", sponsored by the Science Council itself, and one on "Physical and Chemical Approaches to Problems in Chromosomes", sponsored by the International Union of Biological Sciences. The latter had been originally suggested by the International Genetical Society at its last conference at Bellagio, Italy.

The two symposia were held concurrently, at Tokyo and Kyoto. They were attended by some four hundred Japanese geneticists and about a hundred from other countries, the majority of these being from the United States, although there were a few representatives of each of a large number of other nations, both European (including the U.S.S.R.) and Asian. Most of the meetings were held in a fine new building in the centre of Tokyo, the Sankei-kaikan, where there are many small lecture rooms and also a large hall.

On the first morning of the conference, addresses of welcome were given by Dr. H. Kihara, the chairman of the organizing committee, by Drs. S. Kaya and T. Komai, representing the Science Council and Japanese geneticists respectively, and by the Ministers of Education and of Welfare; a reply on behalf of the foreign participants was made by Dr. R. E. Cleland. The conference then got down to business, with a simulating and lucid discussion by Dr. G. W. Beadle on the complicated problem of "Gene Function and Gene Structure", followed by a most valuable general summary, by Y. Tanaka, of the development and present state of genetics in Japan.

On the following days, the conference met in plenary session for general lectures in the mornings, and in separate smaller groups for papers on more specialized topics in the afternoons. The comparatively large number of these sectional groups (about ten) made it impossible for any participant to listen to more than a small fraction of the whole conference, but any disadvantages which might arise from this were, to a large extent, made up for by the excellent facilities for personal meetings and conversations. Not only did most of the lecture rooms open off a large lounge, but our Japanese hosts offered us a number of most delightful informal meals, visits to exhibits, and excursions. Indeed, it is not too much to say that the enormous amount of work which had been devoted to preparing really informative and thorough exhibits, combined with the exceptionally smooth organization of a series of functions which encouraged individual contacts, made this conference one of exceptional value. No one fortunate enough to see the exhibits on silkworm genetics at the State Sericultural Experiment Station,

the work on rice at Hiratuka, on the morning glory at Misima, and the series of exhibits on wheat, radish and goldfish at Kyoto, will have failed to carry away a lasting impression of the peculiar strengths of Japanese genetics. Nor shall we easily forget the seedless water-melons offered us at the Institute organized by Dr. Kihara, their originator, at Yokohama.

Of the more social entertainments, which, as has been already mentioned, played a very important part in the general success of the meeting, some may have been most impressed by the visit to a Kabuki theatre, others perhaps by the trip to the famous architectural show-piece at Nikko. Personally, I think I shall treasure even more the dinner offered us on the first evening at a restaurant named the Hosigaoka-saryo. The banal word 'restaurant' conveys little of the reality of this place. The establishment is, more nearly, a park extending up a steep hill below which the lights of Tokyo stretch glittering towards the horizon. Perched on ledges of the hill are temporary marquees, and permanent pavilions with interiors of the fresh purity of line and colour characteristic of classical Japanese building. In one of these there was Japanese dancing, in another Chinese dishes were to be had, but the centre of attraction was a large terrace at which we were offered an initiation, as thorough as one wished to make it, into the delights of the Japanese cuisine. Attempts to master the trick of managing *hachi* (chopsticks), to identify the delicious but unexpected items of sea-food in the deep-fried fritters known as *tempura*, or the algae or other materials used for wrapping and flavouring the rice balls called *sushi*, to discuss whether the rice-wine *sake* is nicer warm or cold, and if it is really quite strong or not strong at all—such things provided the perfect recipe for breaking the ice on the first day of what proved one of the most pleasant and valuable occasions of international contact which has been held in the biological world for many years.

C. H. Waddington

USE OF ANTIBIOTICS AGAINST PLANT DISEASES

THE title gives the theme of a symposium held on September 28 by the Association of Applied Biologists. The symposium, of eight papers, was mainly devoted to the action of two antibiotics, streptomycin and griseofulvin. The latter, a fungistatic substance produced by *Penicillium* spp., has been used solely against plant diseases. Streptomycin produced by *Streptomyces* spp., on the other hand, was originally used in medical research and has only recently been extensively tested against bacterial diseases of plants.

In some of the experiments discussed, the effects of these antibiotics might have been caused by their action at sites remote from the point of application—a property which contrasts with the action of contact fungicides at or near the point of application only.

In his paper, Mr. S. H. Crowdy (Jealott's Hill Research Station) gave proof that both these antibiotics are absorbed from culture solutions by roots of uninfected plants, and that the amount of griseofulvin taken up is simply related to the amount of water transpired and the concentration in the solution. Once within the plant, their fates vary from one host species to another. The greater proportion of griseofulvin taken up by tomatoes stays in the roots, whereas in broad beans the majority moves from the roots and is found in the lower leaves; little is found in the stems of either plant. In contrast, streptomycin accumulates freely in tomato shoots, but only traces are found in the base of broad bean shoots even after prolonged treatment. Similarly, Lelliott found that streptomycin moves only very slowly from the base of carnation cuttings, and even though the cuttings were in streptomycin solutions containing 100 p.p.m. for only 24 hr., its presence could still be detected after 73 days. The rate of decay of griseofulvin in broad beans is relatively constant—there is a straight-line relation between the logarithm of the percentage griseofulvin surviving and time; 50 per cent of the griseofulvin disappears within 5 days.

Griseofulvin affects the development of a wide range of fungal and allied diseases, for example, those caused by *Plasmodiophora brassicae*, *Fusarium* spp., *Erysiphe* spp. and *Botrytis* spp. Adding griseofulvin to mixtures of unsterilized soil and sand inoculated with resting spores of *P. brassicae* decreases the number of root-hair infections on cabbages, the percentage plants clubbed and the size, at least temporarily, of the clubbed roots. In common with the standard fungicides, griseofulvin is most effective against low concentrations of inoculum. Where griseofulvin is only sufficient to reduce club size temporarily, eventually, when its retarding effect has disappeared, bigger clubs are produced than on the untreated plants. Associated with the larger clubs is a greater weight of foliage. This result probably reflects the ability of large plants when inoculated—in this experiment equivalent to when the griseofulvin no longer inhibited—to develop bigger clubs with less disruption than small plants.

The effects of soil applications of griseofulvin given three weeks after inoculation suggest that it can act systemically against *P. brassicae*. By then infection had occurred and the early stages of club formation within the root cortex were probably taking place. A week later clubs were seen only on the untreated controls, and after a further four weeks the clubs on the untreated controls were still five times larger than on the treated plants (Drs. F. T. Last and I. Macfarlane, Rothamsted Experimental Station).

Further evidence of its systemic properties was given by Dr. A. Rhodes and Messrs. R. Crosse and R. McWilliam (Glaxo Laboratories, Ltd.), who controlled chrysanthemum powdery mildew, a leaf disease caused by *Oidium chrysanthemi*, by watering the roots with a wettable powder formulation of griseofulvin. Although no attempt was made to give equal amounts of active principle, soil applications were more effective than foliage sprays. Sprays containing 0·025 per cent griseofulvin were as effective as 'karathane' (dinitro capryl phenyl crotonate) sprays containing 0·05 per cent active principle.

Two sprays containing 0·025 per cent griseofulvin, one prepared with a wettable powder and the other with an NN-dimethylformamide liquid concentrate, were equally effective against chrysanthemum powdery mildew. The efficacy of the griseofulvin, however, was less in the wettable powder formulation since the powder alone gave significantly greater control of mildew than NN-dimethylformamide. In other small plot tests, griseofulvin controlled the incidence of *Botrytis cinerea* on lettuce and *B. tulipae* on tulips. In the control of the latter disease, tulip

fire, under commercial conditions, griseofulvin sprays were more effective than 'Ferbam' sprays (ferric dimethyl dithiocarbamate) when compared weight for weight of active principle.

The results of experiments done in artificial and natural conditions do not invariably agree. Mr. J. Drew Smith (Sports Turf Research Institute) has found in preliminary trials that spray applications (0·044–0·088 per cent griseofulvin) to turf, before inoculation with *Fusarium nivale* and *Sclerotinia homoeocarpa*, give very effective control of their respective diseases, *Fusarium* patch and dollar spot. In field trials relying on natural infection, however, they appear less effective and do not give as good control as mercury and cadmium fungicides. The apparent drop in the efficiency of griseofulvin may be attributable to changes in its formulation.

Similarly, the field-results using streptomycin do not always confirm the promise shown by initial tests. Of the two materials, streptomycin and 'Agrimycin' (1 : 10 mixture of oxytetracycline and streptomycin), the former was used against *Pseudomonas caryophylli*, the cause of bacterial wilt of carnations, and the latter against *Erwinia* sp., the cause of slow wilt of carnations. The highest minimal bactericidal dose recorded for a range of isolates was 5 p.p.m. of streptomycin against *Ps. caryophylli* and 3 p.p.m. of 'Agrimycin' against *Erwinia* sp.

The effects of these antibiotics on their respective diseases vary with the substrate in which the crops are, when they are applied. By standing a mixture of healthy and infected cuttings in solutions of 50–100 p.p.m. for 24 hr., both materials eliminate transmission but do not cure the infected plants. However, solutions of 'Agrimycin' of similar concentrations do not significantly reduce the spread of slow wilt when watered to cuttings rooting in sand.

The discrepancy between the effective bactericidal doses of both streptomycin and 'Agrimycin' against their respective pathogens in culture and on the host may be attributed to many factors. As with some of the standard fungicides, for example, chloronitrobenzenes, the efficacy of the antibiotics may be affected by the substrate on which the test organism is growing (Mr. R. A. Lelliott, Plant Pathology Laboratory, Ministry of Agriculture, Fisheries and Food).

The effect of streptomycin on bacterial canker of cherry caused by *Pseudomonas mors-prunorum* varies with the stage in the host's development at application. Spraying trees with streptomycin hydrochloride (220 p.p.m.) during the spring blossom period has a large immediate effect in reducing the severity of the necrotic leaf-spotting phase of the disease, but has little persistent effect on the supply of inoculum available for infection of branches in the autumn, as measured by the numbers of bacteria present on the leaf surfaces. Autumn sprays of streptomycin reduce the amount of leaf-surface inoculum, but less effectively than 'low'-strength Bordeaux mixtures. However, despite its apparent inferiority as a surface bactericide, streptomycin is almost as effective in reducing branch infections as Bordeaux mixture. Unequivocal evidence of the systemic activity of streptomycin was not obtained, although the effects of the spring sprays for the control of the leaf-spot phase may be partly attributed to this mode of action (Dr. J. E. Crosse, East Malling Research Station).

At this symposium, there was ample evidence to show that griseofulvin and streptomycin can reduce the severity of a range of plant diseases, and in some trials, notably against chrysanthemum powdery mildew, tulip fire and the silvering disease of beet, the antibiotics were at least as effective as, if not more effective than, the materials at present in general use. The seed-borne organism causing silvering disease of beet, *Corynebacterium betae*, was as effectively controlled by soaking seeds in streptomycin solutions at 200 p.p.m. for 24 hr. as by dusting them with mercury fungicides (Dr. W. G. Keyworth, National Vegetable Research Station).

To gain the maximum advantage from these materials, emphasis should be turned to studying their accumulation within the host in relation to possible disease control. Thus with tomatoes, which accumulate griseofulvin in the roots, the probability of control is greater with root- than with leaf-infecting parasites.

Their use, as with most chemicals, does, however, present a number of hazards. Concentrations of griseofulvin unnecessarily high for the control of clubroot damaged cabbages, and the root growth of carnation cuttings, stood for 24 hr. in streptomycin solutions, progressively decreased as the concentration increased above 50 p.p.m. Rooting hormone can, however, be used as an antidote to this latter effect.

Apart from their harmful effects to plants when used indiscriminately, they may in addition detrimentally affect the health of man, a fact stressed by Dr. R. A. Shooter (St. Bartholomew's Hospital, London). In medical practice, some people, principally those dealing daily with its administration, have developed a sensitivity to streptomycin, and so cannot now avail themselves of its beneficial properties against disease unless de-sensitized. This risk has since been much reduced by making simple alterations in the handling technique. Apart from the preparation of sprays, the risk of developing sensitivity to antibiotics, if used as plant protectants, may arise from exposure to spray drift. It is, however, probably much less than in medicine, since the concentrations used are much lower. The effects described of streptomycin against plant diseases were caused by 0·02 per cent solutions; in medicine, preparations containing 10 per cent are used. Although no examples of sensitization from handling antibiotics included in animal feeding stuffs were quoted during the symposium, the effect of consuming residues persisting on and in sprayed food is still a matter of conjecture and needs investigating.

These two hazards, toxicity to plants and sensitization of man, can be minimized by (*a*) thorough research before making recommendations and (*b*) by careful handling techniques. Already streptomycin is being used against plant diseases in New Zealand and the United States. A possible third hazard, the development of parasites resistant to antibiotics, is, however, less readily combated. Although the minimal dose of a material necessary to kill or inhibit the growth of parasites *in vitro* may be known, it is impossible to maintain such concentrations continuously *in vivo*. Thus conditions occur in which the concentrations of antibiotics are sub-lethal or sub-inhibitory, and in which adjustments in the population of parasites may take place. Although this type of adaptation has not been a serious problem in the control of plant pathogens with standard fungicides in the field, in medicine, and especially with the antibiotics, it causes great difficulties. As yet, antibiotics have been used against plant disease in the field for too short a time to assess the magnitude of this hazard.

F. T. Last

INDUSTRY AND THE TECHNICAL COLLEGE IN BRITAIN

THE handbook entitled "Industry and the Technical Colleges"*, which has been issued by the Joint Federation of British Industries–Technical Colleges Committee under the auspices of the Federation's Education Committee, is based on papers prepared by the Committee as a sequel to discussions at a conference convened by the Federation in May 1954 between representatives of industry and the technical colleges. Among the points covered at the conference were co-operation between industry and the technical colleges, flexibility in technical education, recruitment from the secondary schools, the supply of teachers, sandwich courses, advanced short courses in applied science and technology, research in technical colleges, technological careers for women, the technical college and education for management, and equipment in technical colleges. The handbook, which is published as a contribution to the public discussion of these important issues, sets forth the views and recommendations of the Joint Committee.

Recognizing that a growing proportion of the technicians and technologists required by industry in Britain will come from the technical colleges, the handbook urges the need for greater co-operation, both formal and informal, between industry and the technical colleges: unless they are aware of each other's activities, the colleges will be unable to provide what is needed and industry will not reap the full benefit of the resources available. Accordingly, the Committee recommends that directors and senior executives should be prepared to serve on governing bodies, advisory committees and regional councils and that firms should plan training programmes in close consultation with colleges and expand part-time day release wherever possible. The colleges are recommended to review, where appropriate, the composition and terms of reference of governing bodies and advisory committees, and to adjust courses and teaching methods to the changing needs of industry. They should also encourage the secondment of teachers to industry, and firms are recommended to make available qualified members of their staff for part-time teaching.

As regards courses, firms are recommended to assist actively the development of 'sandwich' courses, and small- and medium-sized firms should co-operate in jointly sponsoring appropriate specialized courses. The co-operation of industrialists in the selection of management students is essential, and firms should inform colleges and regional advisory councils of the calls for special advanced courses. On their side, the colleges should see that syllabuses of vocational courses contain a proportion of liberal subjects and should see both that secondary school boys and girls are more fully informed of their facilities and that more information about advanced courses is brought to the knowledge of industry generally. Research in technical colleges should be expanded and devoted primarily, but not exclusively, to the solution of industrial problems. Teaching staffs should be encouraged to undertake research, and industry could help by grants, gifts and loans of special equipment, and of periodicals and special publications, as well as by establishing research studentships or junior fellowships. The importance of publishing industry-sponsored research whenever possible is stressed.

The handbook recommends the employment of more women in scientific and technological work and suggests that the colleges could help here by training girls for employment in such capacities as laboratory assistants. The need for better technical equipment is also emphasized, and firms are recommended to assist by donations in cash or in kind, while the establishment by the colleges of a central clearing-house for exchange of information on offers of equipment is suggested. The importance of social amenities is likewise stressed, and any help which industry can give in this respect will be a very real contribution towards achieving the aims of technical education in Britain to-day.

* Industry and the Technical Colleges: A Review of Some Current Problems. (F.B.I. Handbook.) Pp. iii+44. (London: Federation of British Industries, 1956.) 3*s*.

SOCIAL AND ECONOMIC RESEARCH

A COMMITTEE with considerable if indirect influence on Great Britain's social and economic policy was set up in 1947 by the then Lord President of the Council and the Chancellor of the Exchequer. The committee is called the Interdepartmental Committee on Social and Economic Research and its members are drawn from university and government departments concerned with social and economic matters either as subjects of study and research or as branches of public administration. The Committee was given the following terms of reference and these have not been changed during the intervening years: "to survey and advise upon research work in government departments, and in particular (*a*) to bring to the notice of departments the potential value for research purposes of the material which they collect and to suggest new methods and areas of collection; (*b*) to advise on how there could be made available to research workers information gathered for their own purposes by the departments which has potential value as material for research".

The Committee has now produced its third report and, in it, surveys the recommendations it has made and the results it has achieved over the past nine years*. Various lines of approach have been used for ensuring that government departments are aware of the interest of research workers in the data assembled for administrative purposes and also in appropriate cases to suggest new methods and areas of collection. For example, general recommendations have been addressed to social and economic departments on such matters as consultation on their statistical programmes; the deposit of unpublished government papers in suitable libraries has been advocated and facilitated; the aims and activities of the Committee have been brought to the notice of a wider public through the publication of reports and "guides to official sources". The more usual procedure during the period under review, however, has been to make suggestions to particular departments after their work and the material which they collect and produce have been intensively studied by one of the specially appointed sub-committees, which are suitably strengthened for the purpose.

The second main concern of the Committee is that research workers should know what material is

* Report of the Interdepartmental Committee on Social and Economic Research (H.M.S.O., 1956).

available and should, within reason, be helped to gain access to it. To some extent the Committee's recommendations have led to the publication of additional material by departments in annual reports or otherwise. The Committee itself has published several "Guides to Official Sources"; has circulated to a select list of university and other research libraries particulars of unpublished material which departments are willing to make available to the libraries; and, on a few occasions, the Committee has been able to put individual research workers in touch with the appropriate departmental officers.

In earlier reports the Committee emphasized how difficult it sometimes was for the research worker to discover what material of relevance to his studies actually existed in government departments and how these could be made available.

Recent investigations suggest that, in general, departments publish statistics more freely than they used to and are usually prepared to deal sympathetically with requests for access to unpublished material in their possession.

The well-proved device of *ad hoc* sub-committees, made up of those members of the Committee with special knowledge or special interest in the subjects under review and reinforced with outside experts co-opted for the purpose, has again been the standard mode of procedure in the examination of the basic questions: what do departments collect; how far is it or could it be published or made otherwise accessible to students; and are there changes in present methods or treatment of the material that seem worth making in the department's own interest on one hand or in that of research workers on the other?

The work of four such sub-committees during 1951–55 is covered by the present report. They were concerned with the Board of Trade; with the proposed content of statistical tables for the reports of the 1951 Census; with local government statistics relating particularly to finance; and with the Ministry of Food.

Recommendations made to departments during the five years ranged widely. Patents, company records, insurance and bankruptcy statistics, as well as statistics relating to the administration of enemy property, are among the subjects on which recommendations were made to the Board of Trade; the Committee also conveyed its views to the Board on the question of publishing selected papers on foreign economic relations.

The registrars general were advised on tables for information obtained by the 1951 Census on birthplace and nationality, education, classification by social class, the cross-classification of occupation within industries, fertility, housing and the characteristics of private households. The Committee also made suggestions for detailed census statistics of the large conurbations (Greater London, west Midlands, south-east Lancashire, Merseyside, west Yorkshire, Tyneside and central Clydeside).

Recommendations were made to those departments concerned with local services and which publish, either in their annual reports or as separate returns, a wide range of local government statistics on such matters as finance, health education, child care, police and fire services and local elections.

The broad nature of the survey of Ministry of Food material did not preclude the committee from making recommendations on points of detail. The report refers to statistics of food supply and procurement, home production, processing and manufacture; stocks; the distribution and use of food; the administration of food controls; prices and margins; and household food surveys. In particular, the Committee pointed to the research interest in the continuance of the National Food Survey and advocated two publications on statistics of food and agriculture: a periodical for current figures and a further addition to the series of "Guides to Official Sources".

The report touches on the relevance to the Committee's work of the recommendations of the Grigg Committee on departmental records, and also emphasizes the importance to research in the social sciences of being able to obtain comparable statistics from each part of the United Kingdom. In the latter connexion, reference is made to the recent production by departments of a key to differences between English and Scottish statistics of crime.

This report serves as a reminder of the need for close co-operation between departments, as the gatherers and producers of information (particularly statistical data) on almost every aspect of economic and social conditions, and the universities and research institutes which can also use that material for the common good.

TREATMENTS AFFECTING FREE ENDOGENOUS GROWTH-SUBSTANCES IN PLANTS

BECAUSE they considered that the possible effects of synthetic auxins and anti-auxins on the metabolism of indole-3-acetic acid have been inadequately studied, L. J. Audus and R. Thresh have investigated the effects of such synthetic substances on the levels of free endogenous growth-substances in plants (*Ann. Bot.*, N.S., **20**, 79, 439; 1956). Seedlings of peas, beans and sunflower were treated with the synthetic auxin, 2,4-dichlorophenoxyacetic acid, and two supposed anti-auxins, 2,3,5-tri-iodo-benzoic acid and maleic hydrazide, at non-toxic levels sufficient to cause well-marked growth responses. Estimates of the content of alcohol-extractable growth-substances were afterwards determined, after separation by paper partition chromatography. Six active natural compounds were indicated in these extracts, but only the effects of treatments on indole-3-acetic acid levels have been followed in detail.

As 2,4-dichlorophenoxyacetic acid treatment of both leaves and roots had no detectable effect on the levels of free endogenous indole-3-acetic acid, the authors conclude that it is an auxin in its own right and does not act on growth by disturbing the indole-3-acetic acid metabolism. There are indications that considerable amounts of the absorbed 2,4-dichlorophenoxyacetic acid are converted in plant tissues to a neutral detoxication product which is easily decomposed to liberate 2,4-dichlorophenoxyacetic acid during chromatographic analysis. Treatment of pea roots by 2,3,5-tri-iodo-benzoic acid is very effective in reducing their free endogenous indole-3-acetic acid content, in some cases to 1/10,000 the normal level. The implications of these findings are discussed in terms of the physiological and morphological responses of plants to 2,3,5-tri-iodo-benzoic acid treatment. The authors state that maleic hydrazide may increase slightly the level of free endogenous auxin in pea roots but that further confirmatory work is required.

THE FLIGHT OF VERY SMALL INSECTS

By G. A. HORRIDGE
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EXPERIMENTAL work on the flight of insects has in general confirmed the view that the wing of an insect in flight acts as an aerofoil[1]. However, there are available aerodynamical results[2] which indicate the existence of a lower limit to the size of an insect wing which can act effectively as an aerofoil. This proves to be near the observed limit of known wings of normal shape, though the structure of certain very small wings indicates a different mechanism of flight.

Accurate measurements of the forces on an aerofoil at very low speeds have been made by Thom and Swart[2]. Working with aerofoil *RAF 6A*, 1·24 cm. chord, 7·5 cm. span, they were able to make measurements in oil down to Reynolds numbers less than unity (calculated on the chord). It was discovered that below $R_e = 10$ the lift is no longer proportional to the square of the velocity for a given angle of incidence, but becomes proportional to the velocity of the free stream. Similarly, the drag coefficient begins to increase at $R_e = 10$, and reaches a value greater than 10 for $R_e = 1$, whereas it is about 0·5 for $R = 100$. The most relevant aspect of these results for insect flight is the ratio, recalculated from their results, of the drag forces to the lift forces, and this is plotted for various values of Reynolds numbering in Fig. 1.

It is clear from the graph that the Reynolds number must be greater than 100 if the inertial components, which ultimately produce the lift, are to be significantly greater than the viscous components, which are responsible for the drag. This means that at Reynolds numbers less than 100 the aerofoil is progressively ceasing to act in the manner that we normally expect at high Reynolds numbers.

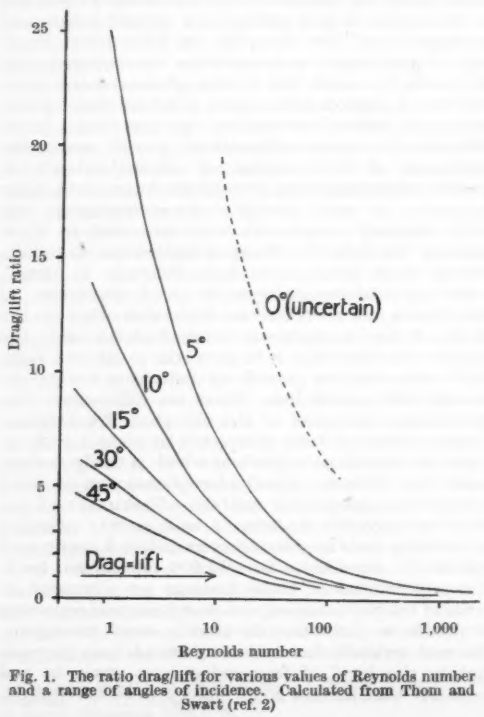

Fig. 1. The ratio drag/lift for various values of Reynolds number and a range of angles of incidence. Calculated from Thom and Swart (ref. 2)

Fig. 2(*a*). Fore-wing of *Anagrus incarnatus incarnatus* Halliday from Debauche (ref. 5)

Fig. 2(*b*). Fore-wing of *Anaphes augustipennis* Debauche

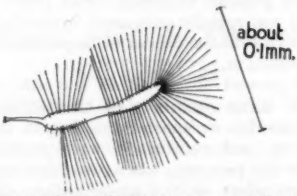

Fig. 2(*c*). Wing of the beetle *Oligella foveolata* Allib. (after Flach, ref. 6)

Now if the values of the Reynolds numbers for various sizes of insect wings with a possible range of frequencies $50 < f < 250$ are calculated, numbers less than 100 appear for the lower ranges of frequency and wing chord. The values calculated in Table 1 are based on a length/breadth ratio of 4/1 (Reynolds number calculated on the chord). As a value for the effective velocity, it is assumed that the wing moves through a distance twice its length (up and down) multiplied by its frequency. This estimate of Reynolds number inclines towards a high value, and for wings of length/breadth ratio 2/1, as in Fig. 2, the results for corresponding numbers are a half of those given.

The smallest insect wings come in a size-range where the Reynolds number alone makes them very inefficient as an aerofoil. I have not been able to discover any figure for the frequency of the wing-beat of the forms illustrated in Fig. 2, but it is unlikely that it will be above the range considered in Table 1. The peculiar fact that such small wings are made of bristles instead of a continuous membrane was noticed by D'Arcy Thompson[3], who suggested that viscous forces play a large part in the action of such wings. The convergence between the hymenopteran mymarid wings (Fig. 2*a* and 2*b*) and

Table 1. Approximate Values of Reynolds Number for Small Wings of Various Breadths

It is assumed for the effective velocity that the wing moves through a distance twice its length multiplied by the frequency per second

Length–breadth ratio = 4

Wing-breadth (mm.)	Frequency/sec. 50	100	150	200	250
0·1	3	6	9	12	15
0·2	12	24	36	48	60
0·4	48	100	150	200	250
0·8	200	400	600	800	
1·6	800				
3·2			$R_e > 1{,}000$		

the beetle *Oligella* (Fig. 2c) is noteworthy. These examples are some of the smallest insect wings, and it seems that they must be operating in the range where viscous drag forces are several times any possible lift forces. It is probable that they have abandoned altogether the aerofoil action and that they literally 'swim' in the air.

Flight would still be possible in these circumstances if there were some mechanism by which the drag on the upstroke is made less than that on the downstroke. If the ratio of downstroke drag to upstroke drag is greater than, say, 5/4, the net upward force from this source would be of the same order as the lift derived from an aerofoil action. A possible mechanism would be to have bristles or a whole wing that bends more easily on the upstroke than on the downstroke. From Thom and Swart's data, it appears that a twist of the wing would not suffice, because the drag at low Reynolds numbers becomes independent of the angle of incidence. Whatever the mechanism, it must be very wasteful of energy.

It is an interesting fact that some of the Mymaridae can 'fly' underwater, using their wings at a frequency of about two beats per second[4], for which there must be some kind of differential drag mechanism.

A feature of Thom and Swart's results is that high angles of incidence up to 45° are effective in producing lift at very low Reynolds numbers. Fig. 1 shows that a lower drag/lift ratio is achieved by high angles of incidence in the range $10 < R_e < 1{,}000$. It is tempting to consider here the general tendency for small insect wings to be without the veins which stiffen their posterior edges. This produces a greater flexibility of the trailing edge and agrees with the lift improvement at high angles of incidence, if at the same time they have given up the active twist of the wing and 'swim' through the air in much the same way as a fish if it had only a passive tail flap. The opinions here advanced can only be confirmed by observation of the insects in question; but the aerodynamical results at low Reynolds numbers certainly indicate a lower size limit to the action of an aerofoil.

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BILIRUBIN, AN UNCOUPLER OF OXIDATIVE PHOSPHORYLATION IN ISOLATED MITOCHONDRIA

By Dr. R. ZETTERSTRÖM and Dr. L. ERNSTER

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JAUNDICE, due to an accumulation of indirect bilirubin according to the van den Bergh reaction (recently established to consist of free, non-conjugated bilirubin[1,2]), is a relatively common and harmless phenomenon in new-born infants whose liver function is not yet fully developed. In prematurely born infants[3], however, or in those born with a hæmolytic disease (for example, that due to iso-immunization), hyperbilirubinæmia may attain an extremely high degree. In such cases, regardless of the etiology of the hyperbilirubinæmia[4], a syndrome of severe brain damage may develop, called kernicterus, or bilirubin encephalopathy[5]. It is also known that high levels of indirect serum bilirubin may lead to liver dysfunction[6,7]. These facts have directed attention to the possibility that free bilirubin might exert a toxic action on tissue metabolism. Working with brain homogenates, Day[8] and Waters and Bowen[9] have recently demonstrated decreased respiration in the presence of bilirubin—an effect which could be reversed[8] by the addition of cytochrome *c* or diphosphopyridine nucleotide[10]. In the present communication evidence is presented that bilirubin uncouples phosphorylation from respiration in isolated liver mitochondria and causes, as a secondary effect, a release of respiratory cofactors, such as diphosphopyridine nucleotide and cytochrome *c*, from the mitochondrial structure.

The experiments were performed with liver mitochondria prepared from white rats (Wistar) according to the method of Schneider and Hogeboom[11]; details of the preparation have been described elsewhere[12]. Mitochondria from one liver, washed twice with 0·25 *M* sucrose, were suspended in 20 ml. of a solution containing 0·15 *M* potassium chloride, 0·05 *M* potassium orthophosphate (*p*H 7·5), 0·001 *M* disodium adenosine triphosphate and 0·06 *M* glucose. The suspension was supplemented with 2 ml. 0·1 *M* magnesium chloride and with an excess of yeast hexokinase, and made up to 30 ml. with 0·25 *M* sucrose. Aliquots of 1·5 ml. of this suspension were added to Warburg vessels containing 30 micromoles substrate and further additions to be tested. The final volume in each vessel was adjusted to 2 ml. with 0·15 *M* potassium chloride. Oxygen consumption was measured at 30° C. for 15 min., including 5 min. of thermoequilibration; the oxygen consumption for this period was calculated by extrapolation. After the manometric recording, the samples were fixed with 0·5 ml. 50 per cent trichloroacetic acid and filtered. Phosphate uptake was estimated in 0·1-ml. aliquots of the filtrates by the isotope distribution method described elsewhere[13]. For the determination of adenosine triphosphatase activity, mitochondria from one liver were suspended in 30 ml. of 0·25 *M* sucrose. Aliquots of 1 ml. were added to 50-ml. Erlenmeyer flasks containing 2 ml. of 0·016 *M* disodium adenosine triphosphate in 0·25 *M* sucrose, 0·4 ml. of 0·5 *M* *tris*(hydroxymethyl)amino-methane buffer (*p*H 7·5), 0·2 ml. of 0·1 *M* magnesium chloride and 0·4 ml. of 0·1 *M* potassium chloride including the individual additions to be tested. When the effect of hypotonicity was to be investigated the mitochondria were suspended in 0·025 *M*, rather than 0·25 *M*, sucrose, and incubated at 30° C. for 15 min. before being added to the reaction mixture.

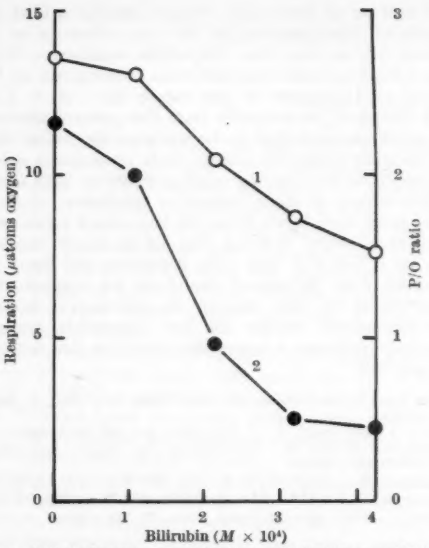

Fig. 1. Effect of varying concentrations of bilirubin on oxidative phosphorylation supported by glutamate. Curve 1, ○—○, respiration; curve 2, ●—●, P/O ratio

Each Warburg vessel contained: mitochondria from 1/20 liver, 30 micromoles potassium L-glutamate, 50 micromoles potassium orthophosphate (*p*H 7·5), 1 micromole disodium adenosine triphosphate, 60 micromoles glucose, 10 micromoles magnesium chloride, 200 micromoles potassium chloride, 100 micromoles sucrose, and 25 microlitres of a stock solution of yeast hexokinase (cf. ref. 16), in a final volume of 2 ml. Gas phase, air; centre well, 0·2 ml. 2 *M* potassium hydroxide. Temp., 30° C. Time of incubation, 15 min.

The flasks were incubated at 30° C. with gentle shaking. Samples of 1 ml. were removed at 0, 10 and 20 min. and added to 2 ml. of ice-cold 10 per cent perchloric acid. After filtration, orthophosphate was determined in 1-ml. aliquots by the colorimetric method adapted[14] from Martin and Doty[15].

Solutions of bilirubin were prepared by dissolving 10 mgm. crystalline bilirubin (Merck Chemical Co., Darmstadt) in 2 ml. of 0·2 *M* potassium hydroxide and adjusting the *p*H to just below 8 by the dropwise addition of 1 *M* hydrochloric acid. The solution was made up with water to 4 ml. and further diluted, when desired, with 0·1 *M* potassium chloride. Biliverdin was obtained by exposing an alkaline solution of bilirubin to oxidation in air, the colour shift being controlled spectrophotometrically.

Fig. 1 shows the effect of varying concentrations of bilirubin on oxidative phosphorylation supported by glutamate. At a concentration of about 3×10^{-4} *M*, bilirubin causes an almost complete inhibition of phosphorylation, accompanied by a partial inhibition of respiration. As shown in Table 1, a similar picture is obtained if glutamate is replaced by α-ketoglutarate, succinate, pyruvate or β-hydroxybutyrate, although the effect on respiration may be less pronounced, or even absent. Among derivatives of bilirubin, so far only biliverdin has been tested and found, as shown in Table 2, to be without effect on either respiration or phosphorylation.

Table 1. Effect of Bilirubin on Oxidative Phosphorylation supported by Various Substrates

Substrate, 30 micromoles. Bilirubin, $4 \cdot 3 \times 10^{-4}$ *M*. Other experimental conditions as in Fig. 1

Substrate	Without bilirubin		With bilirubin	
	Oxygen (μatoms)	P/O ratio	Oxygen (μatoms)	P/O ratio
L-Glutamate	12·1	2·79	7·6	0·54
α-Ketoglutarate	10·1	2·83	12·0	0·67
Succinate	12·3	1·53	8·4	0·24
Pyruvate + 3 μmoles L-malate	12·2	2·58	12·0	0·42
DL-β-Hydroxybutyrate	8·1	2·58	9·1	0·43

Table 2. Comparison of the Effects of Bilirubin and Biliverdin

Experimental conditions as in Fig. 1. Bilirubin or biliverdin, $4 \cdot 3 \times 10^{-4}$ *M*

Addition	Oxygen (μatoms)	P/O ratio
None	13·6	2·32
Bilirubin	7·6	0·45
Biliverdin	13·0	2·63

Table 3. Effect of Bilirubin on Mitochondrial Respiration under Various Conditions

Experimental conditions as in Fig. 1. Additions: bilirubin, $4 \cdot 3 \times 10^{-4}$ *M*; diphosphopyridine nucleotide, $6 \cdot 8 \times 10^{-4}$ *M*; cytochrome *c*, 10^{-4} *M*; 2,4-dinitrophenol, 10^{-4} *M*

Additions	Without hexokinase	With hexokinase	
	Oxygen (μatoms)	Oxygen (μatoms)	P/O ratio
None	2·3	13·6	2·32
Bilirubin	5·1	7·6	0·45
Bilirubin + diphosphopyridine nucleotide		11·6	0·42
Bilirubin + cytochrome *c*		10·9	0·40
Bilirubin + diphosphopyridine nucleotide + cytochrome *c*	13·8	13·9	0·43
2,4-Dinitrophenol	13·7	14·1	0·33

In Table 3 some further effects of bilirubin on mitochondrial respiration are demonstrated. The partial inhibition of respiration, found at higher concentrations of bilirubin, can be prevented by the

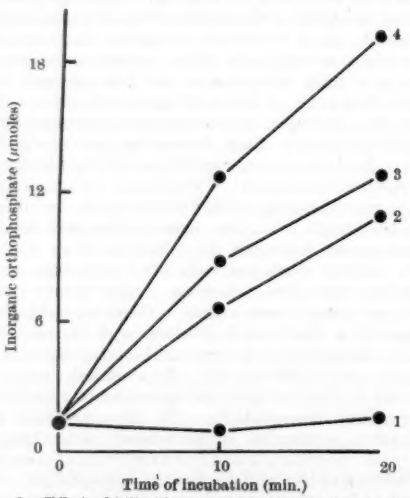

Fig. 2. Effect of bilirubin on mitochondrial adenosine triphosphatase activity

Each of the four series contained: mitochondria from 1/30 liver, 32 micromoles disodium adenosine triphosphate, 20 micromoles magnesium chloride, 200 micromoles *tris*(hydroxymethyl)aminomethane buffer (*p*H 7·5), 40 micromoles potassium chloride, and 750 (in series 3, 525) micromoles sucrose, in a final volume of 4 ml. Incubation at 30° C.

Series 1, no addition or pretreatment; 2, $4 \cdot 3 \times 10^{-4}$ *M* bilirubin added; 3, no addition; mitochondria pretreated with 0·025 *M* sucrose at 30° C. for 15 min.; 4, 10^{-4} *M* 2,4-dinitrophenol added

combined addition of diphosphopyridine nucleotide and cytochrome *c* (or by cytochrome *c* alone in the case of succinate); but these additions fail to prevent the effect of bilirubin on phosphorylation, the phosphate/oxygen (P/O) ratios being invariably low. This indicates that the primary action of bilirubin consists in an uncoupling of phosphorylation from respiration. The loss of the respiratory cofactors, diphosphopyridine nucleotide and cytochrome *c*, may be a secondary consequence of this effect, possibly due to a labilization of the mitochondrial structure. A similar phenomenon has recently been demonstrated to occur when 2,4-dinitrophenol is acting as an uncoupler of phosphorylation in a mitochondrial system which has been supplemented with an extremely high level of hexokinase[16]. Bilirubin seems, however, to be more potent in evoking this secondary effect than is dinitrophenol.

A further indication that bilirubin acts primarily as an uncoupler of phosphorylation from respiration emerges from the fact, also shown in Table 3, that it, like dinitrophenol, is able to induce a maximum level of respiration in mitochondria that have been incubated in the absence of hexokinase, that is, the respiration of which is limited by the lack of a terminal phosphate acceptor[17]. Finally, as illustrated by Fig. 2, bilirubin is a potent inducer of adenosine triphosphatase activity in mitochondria, its action being similar, even in this respect, to that of dinitrophenol[17]. The adenosine triphosphatase activity elicited by bilirubin is, however, lower than that obtained with dinitrophenol; it is of about the same level as that which arises in mitochondria upon ageing in hypotonic medium.

On the basis of the present results, it is concluded that bilirubin in or above a concentration of 3×10^{-4} *M* uncouples phosphorylation from respiration in isolated rat liver mitochondria. This effect is accompanied by a marked elevation of the mitochondrial adenosine triphosphatase activity, and by a release of diphosphopyridine nucleotide and cytochrome *c* from the mitochondria, resulting in a decrease of the respiratory-rate. Although the effect of bilirubin is, at least in the two former respects, similar to that of 2,4-dinitrophenol, bilirubin seems to act more directly on the mitochondrial structure and, thus, it would appear to be premature to consider a common mode of action of the two agents. It is noteworthy that the concentration-range in which bilirubin exerts its action on mitochondrial oxidative phosphorylation coincides very closely with the level (20 mgm. per cent) at which serum bilirubin is known to become critical to the new-born infant[18]. Further aspects, clinical and biochemical, of the present findings are being investigated.

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EFFECT OF METHYLTRYPTOPHAN AND THIOURACIL UPON PROTEIN AND RIBONUCLEIC ACID SYNTHESIS IN CERTAIN HIGHER PLANTS

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THAT nucleic acids are involved in protein synthesis in micro-organisms is at present fairly well agreed. A study of several aspects of the nucleic acid metabolism of fruit trees has given results which throws some light on the relation of nucleic acids to protein metabolism in higher plants.

In previous unpublished work carried out in this laboratory, uracil and xanthine had been found to induce the synthesis of ribonucleic acid and of protein in several species of fruit trees. It was now of interest to study the effect of inhibitors of the purine and protein metabolism in plants in which this synthesis of ribonucleic acid and protein were induced.

From four groups of selected branches of olive trees and grape vines, each group comprising four replicates, one was kept for control and three were sprayed with a 50 p.p.m. solution of uracil. Three days later two of these groups were additionally sprayed with DL-5-methyltryptophan and 2-thiouracil, respectively. After two weeks, leaves were collected from each replicate, carefully washed with an acidified detergent, and analysed for protein and ribonucleic acid. The tissue from one set of samples was extracted with 80 per cent ethanol, and the nitrogen of the insoluble fraction was determined by micro-Kjeldahl[1]. This alcohol-insoluble N-fraction was considered as a preliminary indicator of the protein content. From a second set of samples ribonucleic acid was assayed by a modified alkali method, combining the Schmidt–Thannhauser method[2] and the method developed by Ogur and Rosen[3], in which perchloric acid was substituted for trichloracetic acid. Acid-soluble compounds were extracted with 0·2 *N* perchloric acid. The nucleic acids were extracted[4] with 1 *N* perchloric acid at 37° C., differentially fractionated by 0·35 *N* sodium hydroxide at 20° C., and then determined spectrophotometrically. The nucleic acids were

Table 1. The Effect of Uracil, Methyltryptophan and Thiouracil upon Ribonucleic Acid and Protein Synthesis in Leaves of Olive Trees and Grape Vines

Treatment	Olive trees			Grape vines		
	RNA	Uracil/guanine (molar ratio)	Protein-N per cent dry matter	RNA	Uracil/guanine (molar ratio)	Protein-N per cent dry matter
Control (*C*)	0·81	0·72	1·61	0·60	0·94	1·71
Uracil (*U*)	1·68	0·88	2·38	1·05	1·10	2·17
Uracil + methyltryptophan (*M*)	1·65	0·74	1·74	0·98	0·89	1·64
Uracil + thiouracil (*T*)	0·67	0·79	1·84	0·58	0·84	1·53
Standard error	0·081		0·065	0·070		0·062
Significant difference	$U = M > C = T$		$U > C = M = T$	$U = M > C = T$		$U > C = M = T$

Table 2. The Effect of Uracil, Methyltryptophan and Thiouracil upon the Amino-acid Composition of the Protein Fraction of Olive Leaves

Treatment	Amino-acid-N in μgm./gm. Dry matter					
	Arginine	Aspartic acid	Lysine	Proline	Serine	Tryptophan
Control (*C*)	2,309	1,472	1,864	945	858	1,215
Uracil (*U*)	3,938	2,651	2,888	1,261	1,440	2,337
Uracil + methyltryptophan (*M*)	2,501	1,500	2,131	750	910	772
Uracil + thiouracil (*T*)	2,117	1,274	1,958	794	712	924
Standard error	49	25	31	21	18	33
Significant differences	$U > M > C > T$	$U > M = C > T$	$U > M = C > T$	$U > C > T = M$	$U > M = C > T$	$U > C > T = M$

hydrolysed[5], chromatographed, and the spots were eluted and measured spectrophotometrically[6].

In the 'significant difference' row of Table 1 the treatmonts are arranged in decreasing order of protein and ribonucleic acid content. If significant (at 5 per cent level), the difference between two treatments is designated by a '>' symbol; '=' symbol designates a non-significant difference.

It may be seen from Table 1 that uracil induces an increased synthesis both of protein and of ribonucleic acid, and increases the molar ratio of uracil/guanine. The addition of methyltryptophan stopped the uracil-induced synthesis of protein, while that of ribonucleic acid remained unaffected. On the other hand, the ratio of uracil/guanine is somewhat decreased. Methyltryptophan is known to inhibit the incorporation of tryptophan into protein in certain tryptophan-requiring micro-organisms[4], and it might well be that the decreased synthesis of protein can be ascribed to a similar mechanism. In addition, it might be that methyltryptophan affects the ratio of uracil to guanine, which in turn affects protein synthesis. Since the total synthesis of ribonucleic acid is unaffected by methyltryptophan (that is, by decreased protein synthesis), it seems that it does not depend upon conditions conducive to protein synthesis.

With thiouracil, however, the situation was quite different. This compound, though an inhibitor of purine metabolism, caused a decrease in ribonucleic acid, in the ratio of uracil to guanine, as well as in protein; that is, the inhibited ribonucleic acid synthesis affected the protein metabolism and reduced its amount. Comparing the different effects of thiouracil and methyltryptophan upon ribonucleic acid and protein metabolism, it may tentatively be concluded that in olive trees and grape vines the synthesis of ribonucleic acid and a certain composition of it is apparently a pre-requisite for the synthesis of protein. A similar conclusion was reached with micro-organisms by several other workers[8–11]. The above results suggest that the ratio uracil/guanine, too, is likely to be an important factor for protein synthesis.

It was of interest to make a preliminary study of the way in which the above sprays affect the different amino-acid components of the proteinous fraction. The alcohol-insoluble fraction was hydrolysed with 4 *N* hydrochloric acid at 115° C., and analysed quantitatively by a chromatographic method developed by Thompson and Steward[12]. For the analysis of tryptophan, a separate batch of samples from each replicate was hydrolysed by alkali, and tryptophan was determined by Ehrlich's reagent. Table 2 gives typical variations of those amino-acids which were chiefly affected in olive leaves.

On the data for each separate amino-acid a standard randomized block analysis of variance was carried out (there were no significant block differences). In the 'standard error' row of Table 2, I have given the estimated error (with 9 degrees of freedom) of the treatment means. In the 'significant difference' row the treatments are arranged in decreasing order of acid content as in Table 1.

Table 2 shows that uracil increases significantly the amounts of all amino-acids reported in the table. Treatments with uracil + either methyltryptophan or thiouracil decreased all amino-acids (as compared with the treatment of uracil alone); but thiouracil caused a much larger decrease of arginine (46·2 per cent), aspartic acid (50·2 per cent), lysine (32·2 per cent) and serine (50·1 per cent) than did methyltryptophan.

Similar results were obtained with grape vines.

Further studies are in progress, and a full account of this work will be published shortly.

My thanks are due to Dr. J. Putter, who advised on the statistical analyses.

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LETTERS TO THE EDITORS

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The Sun's General Magnetic Field

WITH their admirable experimental technique, Babcock and Babcock have been able to measure certain very small line displacements in the Sun's spectrum, from which they deduce a general magnetic field of the order of −1 gauss. In order to draw this conclusion they use (although implicitly) two theories: (1) the theory of the Zeeman effect, connecting the line displacements with the magnetic field in a small homogeneous volume of gas; (2) the theory of magneto-turbulence in the photosphere, which, as Babcock's 'point' measurements include many thousand granulæ, is necessary for computing the average.

Whereas the first of these is in order, the second simply does not exist at present. In an answer to criticism by Alfvén, Babcock[2] declares his belief that the effect of magneto-turbulence is small, but does not give any evidence for this point of view. There are several possible mechanisms which have a reasonable chance of occurring. One has been discussed earlier[1], and another can be demonstrated in the following simple example, which does not claim to be rigorous proof but merely serves as another illustration.

Let us consider a quasi-stationary, isothermal state where the generalized pressure is constant in space:

$$nkT_0 + \frac{1}{8\pi}(\mathbf{H}_0 + \mathbf{h})^2 = n_0 kT_0 + \frac{1}{8\pi}\mathbf{H}_0^2 = \text{const.} \quad (1)$$

In equation (1) n is the particle density, n_0 its value when the turbulent magnetic field $\mathbf{h}$ vanishes, $\mathbf{H}_0$ the general magnetic field and T_0 the temperature, which is constant. The total contribution to the Zeeman displacement from a region the extension of which largely exceeds the scale of the turbulence will be given by the mean value $\overline{(nH_z)}/n_0$, where the z-azis is in the direction of sight. From equation 1 the following equation is deduced:

$$\frac{\overline{nH_z}}{n_0} = H_{0z}\left[1 - \frac{\overline{\mathbf{h}^2} + \overline{2h_z^2}}{8\pi n_0 kT_0}\right] \quad (2)$$

It is quite reasonable that in the photosphere the turbulent field should be so strong that the expression in parentheses becomes zero or even negative. Thus, for strong turbulent fields h, the weighted mean given by equation (2) may differ from the proper value H_{0z}, both in magnitude and in the sign.

Babcock[2] cites two observational facts in support of his view: (1) No 'bias' is observed, which according to him is evidence against an influence of turbulence. Dr. Babcock writes that "According to Alfvén's arguments, the systematic effect of f and the way in which ρ and T are coupled with H should provide a large bias . . .". This is erroneous. Alfvén has never drawn this conclusion, nor has Babcock given any arguments for it. Further, according to Lehnert[3] it can be shown, even under very general assumptions, that turbulence will not give a bias.

(2) The Hale polarity law of bipolar sunspots is preserved down to very low magnetic fields. This is very interesting, but as the investigation from which this result is quoted is unpublished, it is impossible to discuss it. In view of the fact that this argument—if valid—is the only existing support for Babcock's sign and magnitude of the solar magnetic field, it is highly desirable that the details should be worked out and published, so that it may be possible to judge whether the conclusion is convincing or not.

The final verdict, whether Babcock's interpretation can be upheld or not, can only be given after a rigorous theory of the magnetic effects of granulation and their influence on the solar spectrum has been provided. No real attempt to develop such a theory has yet been published.

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Direct Measurement of Long-Range van der Waals Forces

ACCORDING to the current theory of the stability of colloids, there exists a universal force of attraction between any two particles which has its origin in the summation of the London dispersion forces between atoms in the two bodies. Although the force between colloid particles is too small to be measured directly, that between macroscopic bodies is just measurable. For example, the theoretical force, F, between two plane parallel plates separated by a gap, d, is given by[1-3]:

$$F \approx A/d^3 \quad (1)$$

if d is less than about 100 A., or

$$F \approx B/d^4 \quad (2)$$

if d is greater than about 2000 A. A and B are force constants which can be calculated. As the theoretical value of B for glass (calculated from the expression given by Lifshitz[3]) is about $1{\cdot}4 \times 10^{-19}$ erg cm., the force at a spacing of 1μ (10^{-4} cm.) should be about $1{\cdot}4 \times 10^{-3}$ dyne per cm.^{2} (that is, 1·4 μgm.).

Two previous attempts which have been made to verify the magnitude of this force experimentally have given highly discrepant results. Derjaguin and Abricossova[4], using an electronically balanced knife-edge microbalance, obtained for quartz over the range 0·1–1μ results which correspond to $B \approx 1 - 2 \times 10^{-19}$ erg cm. Independently, Overbeek and Sparnaay[5] used a method in which the force between parallel glass plates, separated by 0·7–1·5μ, produced a small measured deflexion of a spring. These authors observed a force of 2 dynes at 1μ and their results were represented by equation (1) with $A = 3{\cdot}8 \times 10^{-11}$ erg. If their results were interpreted according to equation (2), the value of B would be 2×10^{-16} erg cm.

We have now carried out a new series of measurements with an apparatus similar in principle to that of Overbeek and Sparnaay but of improved sensitivity. The results of many reproducible experiments, in

which the force between glass plates (optically flat to within 300 A.) was determined over the range 0·7–1μ, indicate that the force at a separation of 1μ is 1·2 (± 0·4) × 10^{-3} dyne per cm.^{2}, and the index of d is 3·9 ± 0·3. Hence, the value of B in equation (2) is 1·2 (± 0·4) × 10^{-19} erg cm.

The theory of the dispersion forces at large distances is therefore confirmed, in full agreement with the results of Derjaguin and Abricossova. In preliminary observations we also observed large forces similar to those reported by Overbeek and Sparnaay; these disappeared on application of a high-frequency discharge or when water-vapour was admitted to the apparatus. These observations add support to the suggestion made by Derjaguin and Abricossova that such forces originate from mosaic electrostatic charges.

Details of this work will be published elsewhere.

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A General Expression for Intermolecular Potentials

A systematic project for the evaluation of virial coefficients (second, third and fourth) by automatic computation has been in operation on the *EDSAC* (Cambridge): tabulated results and mathematical procedures will be given elsewhere. This investigation, however, gave rise to the consideration of a related problem to which the following interesting solution has been found.

In the estimations of intermolecular potentials of spherical molecules to fit observed virial coefficients and related properties, there are a few well-known investigations[1] in which different expressions with two or three adjustable parameters have been tested and advocated. However, it appears desirable, in general, and particularly with respect to the present automatic calculations, to introduce a new expression which has an unlimited number of adjustable constants such as the coefficients of a power series. Such an expression should enable one to make further progress than by the trial of miscellaneous expressions: the agreement for any expression of tabulated functions with two or three parameters must presumably be limited and would be weakened by further improvement and extension of experimental data. This attempt at a systematic procedure seemed to be specially desirable for the most useful organization of the numerical results in the above investigation.

A few different types of expression were examined and the following was selected:

$$U(r) = \frac{4\varepsilon}{(r^2 + B^2)^3} \sum_{i=0} C_{2i} \{r^{2i} \exp A(1 - r^2) - 1\} \quad (1)$$

The intermolecular distance r is to be measured so that the potential $U(1)$ at unity is zero. The constants A and B^2 are to be assigned values about 4 and 1/10, but the constants C_{2i} are to be adjusted to fit experimental or fundamental theoretical data, and their free choice makes the expression dependent on a complete system of functions. The 4 and 1/10 choice has the surprising property that with $C_0 = 1$ and other $C_{2i} = 0$, the function is practically indistinguishable from the Lennard-Jones (12–6) potential,

$$V(r) = 4\varepsilon \left(\frac{1}{r^{12}} - \frac{1}{r^6}\right) \quad (2)$$

This degree of agreement had not been thought possible and is very gratifying, since the use of U provides thus a first term which is probably nearly as good as possible for a two-parameter expression while still permitting unlimited further adjustment.

Table 1

r	$U(r)/4\varepsilon$	
	Potential (1) with $C_0 = 1·0$; $C_{2i} = 0$ $(i > 0)$	(12–6) potential
0·80	7·948	10·737
0·90	1·511	1·659
0·94	0·623	0·652
0·98	0·144	0·146
1·00	0·000	0·000
1·02	−0·101	−0·099
1·06	−0·213	−0·208
1·10	−0·253	−0·246
1·12 (min.)	−0·257	−0·250
1·16	−0·248	−0·242
1·2	−0·227	−0·223
1·4	−0·112	−0·115
1·6	−0·053	−0·056
2·0	−0·015	−0·015
>2·0	Identical	

It does not appear likely that any powerful systematic way for evaluating C_0, C_2, C_4 from experimental data will be found. Their estimation will have to depend on solid-state and viscosity data as well as on the virial coefficients. However, some procedure of successive adjustment of the C_{2i} appears to offer for the first time a systematic way of summarizing the implications of the experimental data. It may also be hoped that this systematization of approach might be of some use in the selection of most effective experimental measurements.

In the work just performed on the *EDSAC*, the second, third and fourth virial coefficients for the basic potential with $(C_2 = C_4 = \ldots = 0)$ and for two others with $(C_6 = C_8 = \ldots = 0)$ have been calculated. Linear combinations of these can then be examined by means of the tabulated results to estimate the best functions to fit experimental data. It may be of interest to note that the calculation depended neither on the analytical form of the potential nor on numerical integration. It was based on an expansion of $\exp(-U/kT) - 1$ in terms of functions of the type $\exp(-ar^2)$. Practically all the organization and arithmetic of the evaluations were performed by the machine.

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Thermal Expansion Coefficients for Uranium Boride and β-Uranium Silicide

THE thermal expansion coefficients for uranium boride (UB_2) and β-uranium silicide (USi_2) have been determined by X-ray powder methods with a high-temperature camera. The mean values for the expansion coefficients between room temperature and 205° C. for different directions in the lattice are summarized in Table 1.

Table 1. THERMAL EXPANSION COEFFICIENT (PER DEG. C.), MEAN VALUE BETWEEN 20° C. AND 205° C.

Compound	Thermal expansion coefficient	Direction in the lattice
UB_2	9×10^{-6}	*a*-axis
	8	*c*-axis
	6	U–B bond direction
β-USi_2	57	*a*-axis
	−26	*c*-axis
	16	U–Si bond direction

These two compounds were selected because of their formally identical crystal structures. They both belong to space group $C\ 6/m\,m\,m$ and are of the AlB_2-type ($C\ 32$)[1-3]. The uranium atoms are situated in the 000 position of the simple hexagonal cell, whereas the non-metal atoms are situated in the $\frac{1}{3}\frac{2}{3}\frac{1}{2}$ and $\frac{2}{3}\frac{1}{3}\frac{1}{2}$ position. The structure may be regarded as formed by plane hexagonal sheets of uranium atoms (*A*) and plane hexagonal networks (*H*) of boron or silicon atoms. The sequence of the sheets in the [001] direction is *AHAHAH* ..... The lattice constants and the interatomic distances for the two compounds are summarized in Table 2. MeB_2-lattices have also been discussed from several aspects by Post *et al.*[4].

Table 2. LATTICE PARAMETERS AND BOND-LENGTHS FOR UB_2 AND β-USi_2 (IN A.)

Compound	Lattice parameters	Distance U–U		Distance U–B (or U–Si)	Distance B–B (or Si–Si, network *H*)
		In sheet (*A*)	Between sheets (*A*)		
UB_2	$a=3{\cdot}136$ $c=3{\cdot}988$	3·14	3·99	2·69	1·81
β-USi_2	$a=3{\cdot}85$ $c=4{\cdot}06$	3·85	4·06	3·01	2·22

A study of the bond-lengths shows that, although uranium boride and β-uranium silicide are isostructural and formed by the same metal atom, several fundamental differences exist which depend on the difference in radius between the boron and the silicon atoms. If the small boron atom (r_B = 0·86 A.) is taken up between the hexagonal uranium sheets, the distance U–U between the sheets of 3·14 A. is still within the limits for a metallic bond to be formed between the uranium atoms. (In the α-, β-, γ-phases of uranium the distances between nearest neighbours of metal atoms varies within the limits 2·75–3·30 A.) The silicon atom (r_{Si} = 1·17 A.), however, is accommodated between the metal sheets only if the uranium atoms are considerably separated (distance U–U = 3·85 A. in the sheets). There is thus probably no bond-formation between the uranium atoms in the metallic sheets of β-uranium silicide.

In the hexagonal networks (*H*) of non-metal atoms in uranium boride, the boron atoms have a separation of 1·81 A., which is 5 per cent larger than the sum of the atomic radii. In β-uranium silicide, however, the silicon–silicon distance of 2·22 A. is 5 per cent smaller than the sum of the atomic radii.

The U–B distance in uranium boride is 11 per cent bigger than $r_U + r_B$ and the U–Si distance in β-uranium silicide is 10 per cent bigger than $r_U + r_{Si}$, using 1·50 A. as the radius for the uranium atom.

The difference in the nature of the bonds in the isostructural compounds uranium boride and β-uranium silicide is clearly reflected in the thermal expansion coefficients for the two lattices. The lattice of uranium boride, with a radius ratio of $r_B/r_U = 0{\cdot}57$, expands uniformly. The coefficient of thermal expansion is nearly equal in different bond directions, indicating that the lattice is held together by bonds of the same nature. It is thus conceivable that the atoms in the same uranium sheets (*A*) are held together by metallic bonds, whereas the distance between the uranium atoms in different sheets is too big (3·98 A.) to permit any direct bond formation. The sheets are held together by the boron atoms, forming uranium–boron–uranium bonds in addition to the boron–boron bonds in the networks (*H*). A possible way might be that electrons from the boron atoms are taken up by the unfilled 6*d*-levels of the uranium atoms and the lattice stabilized by electron oscillation in different bond directions.

For β-uranium silicide the radius ratio r_{Si}/r_U is 0·78. The extraordinarily big thermal expansion of the uranium sheets (the direction of the *a*-axis) probably depends on the facts that no direct binding forces exist between the uranium atoms in the sheets and that the hexagonal networks of silicon atoms parallel to the sheets are considerably 'compressed'. The lattice is held together by silicon–silicon and uranium–silicon–uranium bonds. The negative expansion coefficient between the uranium sheets (*c*-axis) is remarkable and shows that the type of bonding in the β-uranium silicide lattice is different from the bonding in the uranium boride lattice.

Other studies of the thermal expansion coefficients for pairs of isostructural compounds are planned. Uranium boride and chromium boride[3] form, for example, a pair of isostructural compounds where the size of the metal atom is varied for the same non-metal atom. The isostructural pair uranium silicide[3] and iron boride[3] might show other aspects of the nature of the bonds within silicides and borides.

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Symbols for Lattice Disorders

MODERN concepts of crystal physics and chemistry have made it necessary that appropriate symbols should be evolved to designate all kinds of disorders occurring in a crystal lattice. Though several sets of symbols are in use, they are not universally accepted and they are not self-explanatory; indeed, authors often include a glossary of their symbols, which shows that they do not expect the reader to understand or recognize their symbols. It is never

sure whether the sign and number of electric charges in the symbol are meant to express the true charge of the particle at a given site or the difference in charge caused by the disturbance.

The choice of an appropriate symbolism is important for the development of a young branch of science. In the present case, I think it should fulfil the following conditions: (1) It should state which particle is really there at the site in question, indicating its true electric charge. (2) It should state what kind of site is in question: that of a normal lattice cation, or a lattice anion, or an interlattice site. No other legitimate site exists in an ideal crystal, therefore it is misleading to speak, for example, of a vacant bromine *atom* site in a silver bromide crystal where only bromine ions are expected to exist in the ideal case. (3) It should state the difference in electric charge at the given site caused by the disturbance as against the undisturbed ideal lattice, taking care, however, that this difference in charge should not get mixed up with the effective charge of the particle. (4) Symbols which have been more or less generally accepted hitherto should be retained so far as possible, to minimize confusion in the interim period. Thus the symbol □ could be retained for a vacant site, the symbol ○ for an interlattice site, with suffixes if necessary when more than one kind of interlattice site can occur. Probably a strained lattice site around an interlattice atom would deserve a separate symbol for itself, but this problem is generally neglected. The symbol ⊖ should, of course, remain for an electron, but the converse symbol ⊕ should be dropped altogether, because no positrons are to be expected and the 'charge difference' of + 1 against the ideal lattice is simply designated by +, just as a difference of + 2 is indicated by + +.

Several systems of symbols conform with the conditions set out above. I do not venture to decide in favour of any one of them in particular; however, I will direct attention to some which I regard as acceptable. All have in common that the first three points demanded above are provided for at well-defined parts of the aggregate symbol. Further, the whole symbol might be enclosed in rectangular brackets with the real particle first, the site of the particle next and the difference of charge caused by the disturbance at the right higher corner of the end-bracket. The following lattice disorders could be symbolized by one of the four subsequent symbols, taking, for example, a silver bromide lattice:

Vacancy at the site of a silver ion:

$[\square, Ag^+]^-$; $[\square; Ag^+]^-$; $[\square, \mathbf{Ag}^+]^-$; $[\square/Ag^+]^-$

Vacancy at the site of a bromine ion:

$[\square, Br^-]^+$; $[\square; Br^-]^+$; $[\square, \mathbf{Br}^-]^+$; $[\square/Br^-]^+$

An electron at the site of a bromine ion:

$[\ominus, Br^-]$; $[\ominus, Br^-]$; $[\ominus, \mathbf{Br}^-]$; $[\ominus/Br^-]$

A silver ion at an interlattice site:

$[Ag^+, \bigcirc]^+$; $[Ag^+; \bigcirc]^+$; $[Ag^+, \mathbf{O}]^+$; $[Ag^+/\bigcirc]^+$

A sulphide ion at the site of a bromine ion:

$[S^{--}, Br^-]^-$; $[S^{--}; Br^-]^-$; $[S^{--}, \mathbf{Br}^-]^-$; $[S^{--}/Br^-]^-$

A cadmium ion at the site of a silver ion:

$[Cd^{++}, Ag^+]^+$; $[Cd^{++}; Ag^+]^+$; $[Cd^{++}, \mathbf{Ag}^+]^+$; $[Cd^{++}/Ag^+]^+$

Symbols for other disturbances follow naturally from this system. An electron in the conductive band would be simply represented by the symbol of the electron, ⊖; an ion at its own lattice site by its symbol in brackets. Thus the sequence of photo-ionization of a bromine ion and the capture of the freed electron from the conductivity band by a silver ion could be written as:

$$[Br^-] + h\nu \rightarrow [Br, Br^-]^+ + \ominus \text{ and}$$
$$\ominus + [Ag^+] \rightarrow [Ag, Ag^+]^-$$

The dislocation of a silver ion into an interlattice site or its return therefrom into its vacancy would read:

$$[Ag^+] \rightleftarrows [Ag^+, \bigcirc]^+ + [\square, Ag^+]^-$$

I think it is high time that specialists on these problems should attempt to obtain international agreement on a set of symbols that will be universally accepted and as clear and self-explanatory as compatible with the complexity of the situation.

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Spectrophotometry of Granulated Materials, with Particular Reference to Blood Corpuscles

Although expressions have been developed[1,2] for the interpretation of spectrophotometric measurements on granulated materials, little consideration has been paid to the effects of scattering of the incident radiation. Measurements may be made with varying amounts of the scattered radiation received.

(1) *No scattered radiation received* (this is ideally achieved using a parallel beam of radiation with the detecting device subtending zero angle at the suspension). The transmission of a parallel beam through a layer of disks may be calculated by considering the interference between the wave-fronts transmitted by the particle and the medium. If a suspension contains n disk-like particles per c.c. having a thickness t parallel to the beam and an area s perpendicular to the beam, and if the particles are absorbing, having an extinction coefficient E, then the amplitude of the wave emerging from the particle will be reduced by a factor $10^{-Et/2}$ and its phase will differ from that of the remainder of the beam by some angle φ. Considering radiation $A \sin \omega t$ incident on unit area, the wave emerging from a layer of thickness δl will be:

$$A(1 - ns\delta l) \sin \omega t + A\, ns\delta l\, 10^{-Et/2} \sin(\omega t \pm \varphi)$$

and the resultant intensity will be given by the sum of the squares of the coefficients of $\sin \omega t$ and $\cos \omega t$: neglecting terms in $(\delta l)^2$, and integrating over a finite thickness l, the optical density d of the suspension is:

$$d = 2 \log_{10} e.\, nsl\, (1 - 10^{-Et/2} \cos \varphi) \qquad (1)$$

For transparent particles ($Et \rightarrow 0$), the optical density will therefore be a maximum when $\varphi = \pi$, that is, when there is destructive interference between the radiation transmitted through and around the particle: for opaque disks (large Et) no interference can occur and the optical density is reduced. An absorption band will therefore be evident as a decrease in optical density—the exact reverse of normal behaviour.

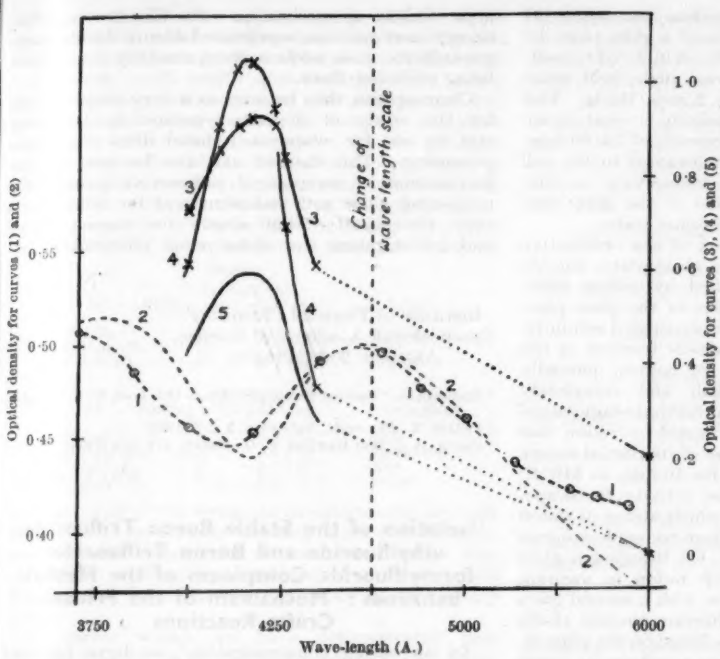

Fig. 1

Blood corpuscles in normal saline are approximately disk-shaped, and calculation shows that $\varphi = \pi$ at a wave-length of 3600 A.—near the γ- or Soret band: measurements were therefore made on a suspension of corpuscles which had all settled to show a circular section to the beam of radiation (the incident and measured beams were parallel[3] to within 1°). The results (curve 1) do show the Soret band inverted, but do not conform to equation (1); a closer approximation to the shape of the corpuscle, namely, two contiguous concentric disks each of area $\frac{1}{2}s$ with the outer ring twice the thickness of the inner disk, leads to an analogous equation which gives curve 2 in fair agreement with experiment.

(2) *All scattered radiation received.* The intensity transmitted through a layer of oriented disks is now the sum of the intensities transmitted through the disks and through the intervening spaces. This leads to an expression[1,2] for the optical density:

$$d_{\text{suspension}} = \log_{10} e \cdot nsl\,(1 - 10^{-El}) \qquad (2)$$

whereas if the absorbing material were uniformly dispersed in the same volume, then the optical density of the solution would be

$$d_{\text{sol.}} = n.\,s.\,t.\,El \qquad (3)$$

These equations indicate that the peak of an absorption band will be depressed when measured on a suspension.

Measurements have been made on oriented blood corpuscles in saline using a converging beam with $F/1{\cdot}5$ lenses above and below the cell, and with the base of the cell ground on both sides so that some of the scattered radiation is collected. (Similar measurements on the alga *Chlorella* have recently been reported[4].) Curve 3 shows a typical absorption curve for a suspension with measurements (curve 4) on the same sample after hæmolysis. Calculation of the optical density from equation (2) gives curve 5. The difference in optical density between curves 3 and 5 may be ascribed to the radiation scattered backwards by the corpuscles; this difference is not, however, independent of wave-length or absorption. The displacement of the maximum of the corpuscular suspension may be at least partly explained by the anomalous dispersion around an intense absorption band[5].

(3) *Some scattered radiation received.* In this intermediate case the minimum of curve 1 and the depressed maximum of curve 3 will tend to cancel out: this would explain the failure of early measurements[6] on corpuscular blood to show the Soret band. This effect is of importance if measurements on powders in disks of potassium bromide, etc., are to be comparable to measurements on a uniform specimen. As much scattered radiation as possible should be collected; and the powder should be ground so finely that the absorption of a single particle is small ($Et \to 0$), when equations (2) and (3) become identical.

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'Clean-up' of Radioactive Gases used for Surface Studies

The gradual decrease of the gas pressure in discharge tubes due to the capture of the gas on the walls and on the electrodes of the tube (electrical clean-up) has been the subject of numerous investigations (for reviews, see refs. 1 and 2). Use of radioactive gas for these studies has several advantages as shown, for example, by Harris and Hawkins[3], who used krypton-85 in measuring gas clean-up rates in switching devices for radar duplexers.

We have now found that the 'clean-up' of radioactive gases can be used as a valuable tool for surface studies because the quantity of the gas cleaned up into the surface, for example, of a glass plate depends to a large extent on the quality of the surface and is affected by the presence of traces of other substances on the surface.

In our experiments radon or radioactive xenon-131 was 'cleaned up' into the surface of a glass plate by a high-frequency discharge produced in a cell consisting of the glass plate and a brass plate held apart by a ring-shaped rubber spacer 2 mm. thick. This cell could be filled with air containing several microcuries of radon or xenon at a pressure of 15–20 mm. mercury. Gas discharge was maintained in the cell for about 30 sec. by simply connecting a plate electrode attached to the outside of the glass wall to the coil of a high-frequency vacuum tester.

The discharge causes a fraction of the radioactive gas to become embedded in the glass plate, and its areal distribution can be checked by taking autoradiographs. Treating the surface of the glass plate with water, organic solvents or concentrated sulphuric acid does not remove an appreciable fraction of the gas from the surface. It is, of course, partially removed by concentrated alkali and completely liberated by hydrofluoric acid. At normal temperature the 'effective' half-life of the cleaned-up radon was found to be about 3 days because of its partial escape by diffusion. Heating the plate for 10 min. to 310° C. caused 60 per cent of the radon activity to escape. The depth of the glass layer in which atoms of radon are embedded can be estimated from recoil phenomena accompanying its alpha-decay. On bringing a glass surface (*A*) with the cleaned-up radon in vacuum into contact for about four hours with a second glass plate *B*, 45 per cent of the equilibrium amount of the short-lived products of radon are found on the plate *B*. Such a high transfer of the decay products by recoil is possible only when most of the atoms of radon are located within a distance from the surface which is small compared with the recoil range of the radium-A atoms in the glass, which is of the order of 200 A.

Areal concentration of the cleaned-up gas is fairly homogeneous over the whole glass surface cleaned chemically, for example, with sulphuric acid potassium permanganate solution, rinsed with re-distilled water and dried. Traces of impurities or various substances such as grease, solid hydrocarbons or polymers covering the surface in the form of thin films inhibit, according to their thickness partially or completely, the ability of the surface to clean-up radioactive gas, and their presence is easily revealed by autoradiographs. Disturbing the surface layer of the glass by grinding it with fine 'Carborundum' powder or by treating it with hydrofluoric acid also modifies the ability of the surface to clean-up gas. Typical examples of these effects are demonstrated in Fig. 1. This is an autoradiograph of a glass surface on which, previous to radon clean-up, a drop of 2×10^{-3} *M* solution of stearic acid in petroleum ether had been evaporated and a strip of its surface about 2 mm. wide was ground with 'Carborundum' powder.

Stepwise deposition of odd numbers of monomolecular layers of calcium stearate on the glass surface (Langmuir–Blodgett technique) resulted in clean-up radiographs with steps of decreasing density corresponding to various thicknesses of the deposited film. A single monolayer of stearate of about 25 A. thickness is sufficient to cause a distinct decrease in the ability of the surface to clean-up radioactive gas. This can be understood on the basis of a mechanical type of clean-up mechanism: the film prevents low-energy inert gas ions, accelerated during the discharge towards the glass surface, from reaching it and from being occluded there.

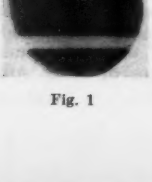

Fig. 1

Clean-up can thus be used as a very simple means for the study of deposited monomolecular films, and its use for evaporated metal films also seems promising. This method can also be used for the preparation of samples of radioactive gases when measuring their soft radiation and for obtaining a very convenient radon source for demonstrating and investigating the alpha recoil phenomena.

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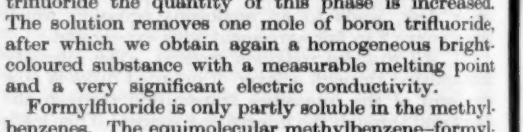
Isolation of the Stable Boron Trifluoride-ethylfluoride and Boron Trifluoride-formylfluoride Complexes of the Methylbenzenes: Mechanism of the Friedel–Crafts Reactions

In an earlier communication[1] we have reported the isolation of the stable boron trifluoride–hydrogen fluoride complexes of the methylbenzenes and described the carbonium ion salt (or σ-complex) structure of these compounds.

We have now succeeded in isolating the stable complexes from the methylbenzenes with ethylfluoride–boron trifluoride and formylfluoride–boron trifluoride. On dissolving equimolecular quantities of ethylfluoride in toluene, *m*-xylene and mesitylene at − 30° to − 80° a homogeneous clear solution is obtained. Introduction of boron trifluoride into the solution leads to the separation of a bright-coloured lower phase, and by continuing the addition of boron trifluoride the quantity of this phase is increased. The solution removes one mole of boron trifluoride, after which we obtain again a homogeneous bright-coloured substance with a measurable melting point and a very significant electric conductivity.

Formylfluoride is only partly soluble in the methylbenzenes. The equimolecular methylbenzene–formylfluoride mixture becomes immediately brightly coloured on introduction of boron trifluoride and becomes homogeneous by losing one mole.

The 1 : 1 : 1 molecular complexes can be formulated, for example, in the case of mesitylene, in the following manner:



In this case we have been able to isolate the intermediate complexes of the Friedel–Crafts ethylation and formylation of aromatic compounds.

By the slow thermal decomposition of the complexes the homogeneous substance separates again

into two phases: an upper organic phase, which was identified after washing and distillation as an ethyl methylbenzene and formyl methylbenzene respectively, with nearly quantitative yield; and a lower phase, which contains the stoichiometrical quantity of hydrogen fluoride with a negligible quantity of the dissolved aromatic. By the action of the hydrogen fluoride on the aldehyde produced in the formylation reaction some tarry material is formed, probably by the polymerization of the aldehyde.

The properties of the isolated $ArHC_2H_5^+BF_4^-$ and $ArHCHO^+BF_4^-$ complexes are given in Table 1.

Table 1

Ar	$ArHC_2H_5^+BF_4^-$ Melting point (°C.)	$\varkappa(\Omega^{-1}.cm.^{-1})$	Colour
$C_6H_5C_2H_5$	−80	$0{\cdot}2\times10^{-2}$	Yellow
$m(CH_3)_2C_6H_4$	−75	$0{\cdot}1\times10^{-2}$	Red
$s(CH_3)_3C_6H_3$	−15	$0{\cdot}2\times10^{-2}$	Orange

Ar	$ArHCHO^+BF_4^-$ Melting point (°C.)	$\varkappa(\Omega^{-1}.cm.^{-1})$	Colour
$C_6H_5CH_3$	−70	$0{\cdot}4\times10^{-2}$	Red
$m(CH_3)_2C_6H_4$	−52	$0{\cdot}5\times10^{-2}$	Cherry-red
$s(CH_3)_3C_6H_3$	−16	$0{\cdot}7\times10^{-2}$	Red
$as(CH_3)_3C_6H_3$	−10	$0{\cdot}7\times10^{-2}$	Cerise

As a result of the foregoing investigations, we have been able to investigate the ethylation and formylation of a methylbenzene, for example, toluene with the boron trifluoride – catalysed action of ethylfluoride and formylfluoride, so to say in elementary steps.

In earlier work[2], we have demonstrated that ethylfluoride forms at low temperature a 1 : 1 molecular complex with boron trifluoride. This molecular complex has at above − 95° a specific conductivity of $\varkappa = 0{\cdot}5\times10^{-6}\ \Omega^{-1}.\ cm.^{-1}$ in the melted state. From this low conductivity value it is evident that the complex has mainly a polarized covalent character and can be only to a very slight degree ionized. This is in full agreement with H. C. Brown's[3] suggestion of the first step of the alkylation reaction of aromatics by the aluminium halide – catalysed reaction with ethyl halides.

Also in earlier work[4] we have demonstrated that formylfluoride forms at low temperature a 1 : 1 molecular complex with boron trifluoride. This complex has at − 110° a specific conductivity of $\varkappa = 0{\cdot}1\times10^{-2}\ \Omega^{-1}.\ cm.^{-1}$ in the melted state. From this high conductivity value it is evident that the complex has a carboxonium ion salt structure similar to the acetyl tetrafluoroborate isolated earlier by F. Seel[5].

The ethyl borofluoride complex which we have prepared at a low temperature is a colourless compound which melts with decomposition at about − 95° and has—as mentioned—a very small specific conductivity. If we add now—also at low temperature—an equimolecular quantity of cold toluene to the ethyl borofluoride complex, the colour is changed immediately to bright yellow, the specific conductivity increases to a value of $\varkappa = 0{\cdot}2\times10^{-2}\ \Omega^{-1}.\ cm.^{-1}$ and we obtain the homogeneous well-identified complex as in the case of the one-step complex formation described earlier in this communication.

In the case of the formyl tetrafluoroborate the complex we have prepared is a colourless compound, which decomposes at about − 110°. If we add now, also at low temperature, an equimolecular quantity of cold toluene to the formyl tetrafluoroborate complex, the colour is changed immediately to bright red. The specific conductivity increases to $\varkappa = 0{\cdot}4\times10^{-2}\ \Omega^{-1}.\ cm.^{-1}$ and we obtain the homogeneous well-identified complex as in the case of the one-step complex formation between toluene, formylfluoride and boron trifluoride.

We formulate, on the ground of the direct preparative proofs of the isolation of the two intermediate complexes, the electrophilic alkylation and formylation mechanism in the following manner (for the sake of simplicity we indicate only the formation of the *para* product):

$$C_2H_5{-}F + BF_3 \rightleftharpoons \overset{\delta+}{C_2H_5} \rightarrow F \rightarrow \overset{\delta-}{BF_3}$$

$$\overset{\delta+}{C_2H_5} \rightarrow F \rightarrow \overset{\delta-}{BF_3} + \bigcirc\!\!-CH_3 \rightleftharpoons \left[\begin{matrix} H \\ C_2H_5 \end{matrix}\!\!\bigcirc\!\!-CH_3\right]BF_4^-$$

$$\rightleftharpoons C_2H_5\!\!\bigcirc\!\!-CH_3 + HF + BF_3$$

$$HCOF + BF_3 \rightleftharpoons [HCO]^+BF_4^-$$

$$[HCO]^+BF_4^- + \bigcirc\!\!-CH_3 \rightleftharpoons \left[\begin{matrix} H \\ CHO \end{matrix}\!\!\bigcirc\!\!-CH_3\right]^+BF_4^-$$

$$\rightleftharpoons OHC\!\!\bigcirc\!\!-CH_3 + HF + BF_3$$

We believe that the isolation of the onium-ion salt intermediate complexes makes possible a better understanding in general of electrophilic aromatic substitutions.

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Super-Acid Formation in the Pyridine–Acetic Acid System

A STUDY of the physico-chemical properties of mixtures of pyridine and acetic acid in all proportions ranging from 0 to 100 per cent by various workers and very recently by us[1] showed that the equivalent conductivity, viscosity, contraction in volume, and refractive index exhibited in each case a maximum at a composition of 83 mol. per cent of acetic acid. Previous workers ascribed the maxima to the formation of a complex at that composition. A consideration of the dynamics of ionic atmospheres in relation to the effect of an electrolyte dissociating into ions on the viscosity of a solution and other factors (*loc. cit.*) led us to assume that no compound-formation occurs, and that, instead, at that composition acetic acid attains maximum ionization. At least 17 mol. per cent of pyridine is necessary for complete ionization of acetic acid in pyridine.

The hydrogen ions thus obtained from the acetic acid dissociation must be assumed[2,3] to exist as pyridinium ions involving one pyridine molecule for each hydrogen ion. But when the number of pyridine molecules is insufficient to form pyridinium ions some free hydrogen ions have to be assumed to exist, and necessarily so at 83 mol. per cent composition of acetic acid, where the dissociation is complete. It is to be expected that a study of *p*H at different compositions of the mixture starting from 0 to 100 per

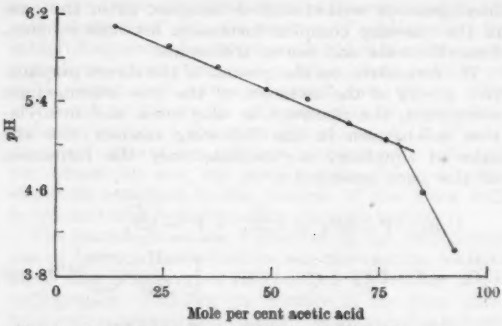

Fig. 1. Graph showing *p*H of pyridine–acetic acid system

cent pyridine should indicate a minimum at 17 mol. per cent of pyridine, at which composition acetic acid dissociates completely.

We have studied the *p*H of mixtures of pyridine and acetic acid and the results are represented graphically in Fig. 1. The measurements were made with a glass electrode in conjunction with a saturated dip-type calomel electrode in a Morton's glass electrode assembly unit with a Cambridge *p*H meter. The values obtained were quite reproducible. Surprisingly, the *p*H behaviour between 83 and 100 mol. per cent of acetic acid is quite the reverse of our expectation. In this region, for conductance as well as *p*H, the same downward trend makes it inevitable that the free hydrogen ions left over, due to an insufficient number of pyridine molecules to form pyridinium ions, must be assumed to have attached themselves to undissociated acetic acid molecules, forming $CH_3COOH_2^+$ ions exhibiting the well-known super-acid behaviour[4–6]. The *p*H curve thus proves the existence of undissociated molecules of acetic acid in the region 83–100 per cent acetic acid, as well as super-acid formation.

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Structure of a Grass Pollen Flavonoid Glycoside

A flavonoid glycoside, dactylin, was found to occur in pollens of timothy and orchard grass in 1931 by Moore and Moore[1]. Until this present study, there existed no complete structural data on dactylin. An abstract by Johnson *et al.*[2] indicated that dactylin was not chromatographically similar to simultaneously processed *iso*quercitrin, quercitrin and quercetin. They also report that spectrographically dactylin aglycon and quercetin, individually and mixed, have identical patterns in three solvent systems.

For the studies reported here[3], dactylin was re-isolated from timothy pollen. It was obtained as a light yellow solid from a 1955 crop of defatted pollen. It was readily recrystallized from water, and paper chromatography revealed only one spot in three solvent systems. The methoxyl content was 3·60 per cent, and the dactylin aglycon (obtained by 2 *N* sulphuric acid hydrolysis of dactylin) revealed 6·93 per cent methoxyl content. Infra-red and ultra-violet spectra and melting-point data suggested the aglycon to be impure *iso*rhamnetin. Acetylation of the aglycon gave 3,5,7,4′-tetra-acetoxy-3′-methoxyflavone that had an infra-red spectrum identical in every respect with a known sample. On admixture with the known sample, no depression of melting point was observed. Methylation of the aglycon with diazomethane gave 3,7,3′,4′-tetramethoxy-5-hydroxyflavone that also had an infra-red spectrum identical in every respect with a known sample. On admixture with a known sample, no depression of melting point was observed.

When dactylin was methylated with diazomethane and hydrolysed, 5,7,3′-trimethoxy-3,4′-dihydroxyflavone was obtained that was identified by mixed melting point and identical infra-red spectrum with a known sample. The reference sample was kindly supplied by Dr. Richard Kuhn, of the Max Planck Institute for Medical Research. Therefore, the structure of dactylin was shown to be *iso*rhamnetin 3,4′-diglucoside and identical with the flavonoid glycoside isolated and characterized by Dr. Kuhn from the pollen of *Crocus* Sir John Bright[4].

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Chromatographic Study of Jute α-Cellulose

A number of papers and communications have been published by different workers in recent years on the chromatographic study of jute α-cellulose, and conflicting views have been expressed regarding its association with different sugar residues. Sarkar *et al.*[1] consider the material to be entirely composed of glucosan, while Das and co-workers[2] contend that it is intimately associated with both xylose and arabinose residues. Adams and Bishop[3] believe that, in addition to these pentosans, jute α-cellulose contains uronic acid residue, the presence of which is yet to be confirmed by the chromatographic analysis.

Although Sarkar and others[1], and Adams and Bishop[3] have employed the same hydrolytic procedure of 72 per cent sulphuric acid, the failure of the former authors to detect pentoses in the hydrolysate appears to be due to interference caused by the presence of a large amount of glucose which has, however, been preferentially removed by the latter authors by the action of an enzyme preparation. Das *et al.*[2], and more recently Adams and Bishop[4], have applied a method of selective hydrolysis with formic acid to identify pentosans in jute α-cellulose, although Mazumdar and Sarkar[5], on using the same procedure, have failed to substantiate this observation.

It was noted, during the preliminary experiments carried out in this laboratory, that only glucose and xylose could be detected on the chromatogram of the jute α-cellulose hydrolysate obtained with the 72 per cent sulphuric acid method. The work described in

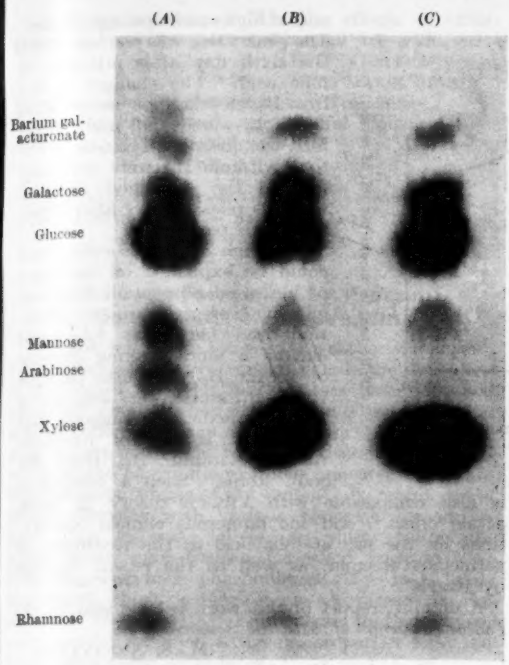

Fig. 1. Chromatogram with three successive runs of 56, 36 and 30 hr.: (*A*) reference sugars; (*B*) α-cellulose isolated by 9·5 per cent alkali; (*c*) α-cellulose isolated by 17·5 per cent alkali

this communication, however, has shown that on changing the hydrolytic procedure, that is, by using a dilute sulphuric acid solution instead of strong acid to effect only a partial hydrolysis, the conversion of glucosan to simple sugar is greatly restricted and, on following the technique of interrupted development of the chromatogram, it is possible to identify a number of associated sugars in addition to those already reported[2–4].

A small quantity of α-cellulose (0·5–2 gm.) is usually hydrolysed for the chromatographic analysis; but in the present investigation, a larger amount of the sample (10 gm.) was employed with the view of obtaining a more concentrated extract of associated sugar residues, particularly of those occurring in small proportions. Jute α-cellulose was prepared by treating the isolated chlorite holocellulose with sodium hydroxide solution under two different conditions, namely, (1) 17·5 per cent alkali at 20° C. according to the A.C.S. method and (2) 9·5 per cent alkali at room temperature. The sample was partially hydrolysed on heating with *N* sulphuric acid (200 c.c.) by immersing the reaction vessel in boiling water for 1 hr., when the material suffered a loss in weight of 4–6 per cent. The extract was further hydrolysed by refluxing for 6 hr., neutralized with barium carbonate to *p*H 5·6, concentrated at 35° C. to a small bulk and chromatographed on Whatman No. 1 filter paper with *n*-butanol – acetic acid – water (1 : 0·24 : 1) as the solvent, sugars being detected on spraying with aniline hydrogen phthalate. When the chromatogram was run at a stretch over a prolonged period (96–120 hr.) in order to effect separation of individual components, the spots of sugars occurring in small amounts became too faint to be detected with certainty by visual examination. On interrupting the flow of the chromatogram, that is, by subjecting the paper to three successive runs, initially for 56 hr. and then twice for 36 and 30 hr., sugars could be easily identified, although the shape of the spot suffered a considerable change from that obtained after a single run.

A typical chromatogram (Fig. 1) of the hydrolysate obtained from white jute α-cellulose, prepared by two different procedures, shows the presence of barium uronate, galactose, mannose and rhamnose in addition to glucose, xylose and arabinose already identified; the spot of arabinose is particularly faint in the case of the sample prepared with 17·5 per cent alkali. The hydrolysate from tossa jute α-cellulose also yielded a similar chromatogram and, from the size and intensity of the spots obtained, the material appeared to be associated with increased amounts of both xylose and arabinose. Individual sugars were isolated after separation on Whatman No. 3 *MM* filter paper and confirmed by measuring the respective R_F values, further confirmation of uronic acid being obtained from naphthoresorcinol and that of galactose from mucic acid tests. Jute α-cellulose, therefore, appears to be associated, irrespective of its method of isolation, with mannose in addition to the other sugars so far detected in the holocellulose fraction[6].

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Rise of Serum Folic Acid-Levels after Injection of Vitamin B_{12} in Nutritional Macrocytic Anæmia

Although certain similarities between folic acid and vitamin B_{12} as agents involved in hæmopoiesis, nucleic acid synthesis and single-carbon transfers are well known, there is very little information on the manner in which these two chemically dissimilar vitamins affect each other. We wish to make a preliminary report of observations which show that the administration of vitamin B_{12} causes a rise in the serum folic acid-level in patients with nutritional macrocytic anæmia.

The total vitamin B_{12} content in the serum was determined by a modification of the microbiological (*Euglena*) method of Ross[1] using the extraction procedure of Shenoy and Ramasarma[2]; the folic acid content was determined microbiologically with *L. casei* as the test organism[3].

In some of the earlier cases of nutritional macrocytic anæmia treated with daily injections of 10 mgm. of folic acid, a definite increase in serum vitamin B_{12} concentration was noticed 24–72 hr. after commencement of therapy, whereas in others no significant changes could be seen. If this increase was due to mobilization of vitamin B_{12} from tissue stores, it is reasonable to expect a bigger rise in patients who have larger stores of vitamin B_{12}. In order to test this

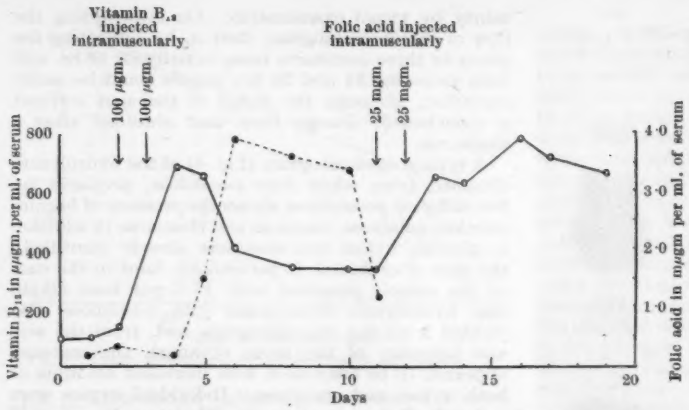

Fig. 1. Changes in serum concentrations after injections of vitamin B_{12} and folic acid in a patient with nutritional macrocytic anæmia. ○——○, vitamin B_{12}; ●——●, folic acid

hypothesis and also to test the effect of parenteral vitamin B_{12} on serum folic acid-levels, the following general plan was adopted.

After a control period of five to nine days, each patient was given two intramuscular injections of 100 µgm. of vitamin B_{12} on consecutive days. Eight days later, he was given two intramuscular injections of 25 mgm. of folic acid on consecutive days and was kept under observation for a week or more. The results are summarized in Table 1, and a striking example is shown in Fig. 1.

The pretreatment values for serum folic acid were within the range 0·28–2·55 mµgm. per ml. However, these values increased several-fold after the administration of vitamin B_{12}, the peak-levels being usually reached within three to seven days. These results confirm the observations made by Nieweg *et al.*[4].

The initial concentrations of serum vitamin B_{12} in most of the patients were subnormal (less than 100 µµgm./ml.) or marginal. The injection of vitamin B_{12} caused a sudden rise in the serum-levels which, as can be expected, showed a rapid fall during the next three or four days. Thereafter the values declined slowly or remained practically constant. Of particular interest was the observation that, in every case studied, the trend of falling vitamin B_{12}-levels was reversed in 24–48 hr. after the injection of folic acid. In all cases the subsequent rise was sustained and of high statistical significance. The peak value was reached about the sixth day after injection of folic acid. The changes in the free B_{12} levels (not included in Table 1) were small and, therefore, the observed increases in the total vitamin B_{12} were obviously due to the combined vitamin, which is released only after digestion with papain.

Although the observed rises could be explained on the basis of increased absorption from the gut or decreased urinary excretion, the fact that folic acid elicited a more striking increase of serum B_{12} in those patients whose B_{12} stores were augmented by prior medication suggests that its action is one of mobilization of vitamin B_{12} from the body stores. Such a conclusion is also compatible with Vilter's theory of 'mass action effect'[5], and the numerous clinical observations on the use of folic acid in the treatment of pernicious anæmia[6] as well as the recent findings by Harris[7].

A detailed report of this work will be sent to the *Indian Journal of Medical Sciences*.

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Table 1. Summary of Data on Serum Folic Acid and Vitamin B_{12} Levels in 13 Nutritional Macrocytic Anæmia Patients during Treatment

	Folic acid content (mµgm./ml.)		Vitamin B_{12} content (µµgm./ml.)	
	Before B_{12} injection (*a*)	After B_{12} injection (*b*)	Before folic acid injection (*c*)	After folic acid injection (*d*)
Range	0·28–2·55	1·37–5·85	180–598	269–978
Average	0·94	2·87	414	662
Mean difference	1·93		248*	
t	6·4		6·5*	
P	< 0·1 per cent (highly significant)		< 0·1 per cent (highly significant)	

a, Mean of values for three consecutive days; *b*, mean of six values during 8 days; *c*, mean of three values during 4 days; *d*, mean of five values during 7 days.

* In another series of nine patients in whom only the serum B_{12} concentrations were studied, the mean difference of 123 µµgm./ml. was found to be highly significant ($t = 5·7$, $P < 0·1$ per cent).

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Effects of Chlorpromazine and Dinitrocresol

The observations of Berger, Strecker and Waelsch[1] on the action of chlorpromazine on oxidative phosphorylation of mitochondria prompt us to report that chlorpromazine has been observed to potentiate the action of 2,4-dinitro*ortho*cresol (DNC) in white mice. Mice weighing 16–21 gm. were given this substance subcutaneously, followed immediately by chlorpromazine hydrochloride intraperitoneally. The results obtained (at a room temperature of 25° C.) are as follow:

Dose	No. of animals	No. dead after 24 hr.
20 mgm./kgm. DNC	10	1
20 mgm./kgm. DNC+ 5 mgm./kgm. chlorpromazine	10	6
25 mgm./kgm. DNC	10	6
25 mgm./kgm. DNC+ 5 mgm./kgm. chlorpromazine	10	8
25 mgm./kgm. DNC+ 10 mgm./kgm. chlorpromazine	10	9
5 mgm./kgm. chlorpromazine	10	0
10 mgm./kgm. chlorpromazine	10	0

These figures suggest that the effects of chlorpromazine and 2,4-dinitro*ortho*cresol are additive.

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Antibody Formation by Protein Components of Bee Venom

It is not yet known for certain whether the physiological responses to bee venom include the formation of antibodies. Earlier investigators have obtained divergent results when investigating immunization against different effects of the venom. This is probably in part due to the fact that a series of pharmacological and enzymatic reactions are caused by quite different constituents of the venom[1]. In recent years, several proteins with various biological properties have been isolated: first, the pharmacologically highly active toxin-fraction (so-called 'fraction I')[2]; then the enzymes phospholipase *A* [3] and hyaluronidase[4], which on electrophoresis migrate in the so-called 'fraction II'. From these findings arises the question whether antigenic properties may be found with these substances.

Solutions of cautiously dried bee venom were injected intravenously into rabbits at intervals of one to two weeks. Before every injection samples of serum were obtained and stored at − 6° to − 8° C. Repeated doses of 0·2 or 1·0 mgm./kgm. caused increasing formation of antiphospholipase and antihyaluronidase in the sera (cf. Fig. 1). On the other hand, the effects of bee venom on the isolated guinea pig auricle or frog heart, the frog sartorius, guinea pig gut or uterus, and also its systemic toxicity in white mice and the (direct) hæmolysis of human erythrocytes by fraction I, were not diminished by the sera of the immunized rabbits to a greater degree than they were by normal rabbit serum.

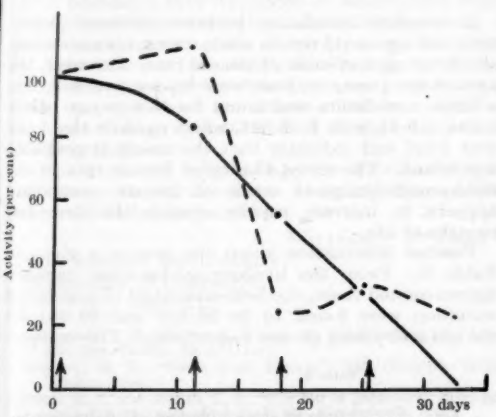

Fig. 1. Increase of antiphospholipase and antihyaluronidase potency of rabbit serum after repeated intravenous injections of bee venom. At arrows: 1 mgm./kgm. bee venom. Activity is given as a percentage of the activity of a control (venom + stored normal serum). ·——·, hyaluronidase (ref. 5); venom, 1 : 20,000, serum, 1 : 40. ·– – –·, phospholipase *A* (ref. 5); venom, 1 : 336,000, serum, 1 : 42

The experiments show that two enzymes—phospholipase *A* and hyaluronidase—of bee venom give rise to immunization, whereas the non-enzymatic but pharmacologically highly active toxin-fraction I seems to be non-antigenic.

The investigations will be extended, and a detailed description of methods and results will be published in the dissertation of one of us (El K.).

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Formation of Erythulose from Hydroxypyruvate in the Presence of Yeast Carboxylase

Hydroxypyruvate is a metabolite which can arise from the biological oxidation of glycerate[1], transamination of serine[2], or decarboxylative condensation of glyoxylate[3]. In the presence of cocarboxylase, magnesium ions and transketolase, it yields 'active' (cocarboxylase-bound) glycolaldehyde, capable of forming a ketopentose 5-phosphate with D-glyceraldehyde 3-phosphate[4,5] or sedoheptulose 7-phosphate with D-ribose 5-phosphate[5,6]. Transketolase decarboxylates hydroxypyruvate only when a suitable acceptor aldehyde is present[5] (acetaldehyde will not serve[7]) and does not decarboxylate pyruvate[5,7]. Crude yeast pyruvate carboxylase, on the other hand, has been stated not to decarboxylate hydroxypyruvate[8].

The conclusions of Akabori *et al.*[9] that muscle minces cause a decarboxylative acetoin type of condensation of dihydroxyfumaric acid, leading by way of a hydroxypyruvate intermediate to the formation of tetrose and hexose sugars, led us to re-investigate the action of partially purified yeast carboxylase, prepared from several varieties of yeast, on pure lithium hydroxypyruvate[1]. Contrary to the experience of Meister[8], we observed a slow steady decarboxylation at *p*H 5, and this became vigorous at *p*H 6·5. Colorimetric estimation[1] confirmed the disappearance of hydroxypyruvate, with little or no formation of free glycolaldehyde. A neutral reducing substance accumulated in good yield, having R_F on paper chromatographic analysis in phenol/water of 0·695, identical with that of pure L-erythulose and distinct from that of erythrose (R_F = 0·65). This enzymically synthesized tetrose gave a crystalline *o*-nitrophenylhydrazone (found N = 16·5 per cent, calc. 16·5 per cent), melting point 150°, unchanged on admixture with authentic erythulose *o*-nitrophenylhydrazone. Determination of the optical rotation in ethanol of this derivative gave $[\alpha]_D = + 48° \pm 3°$, thus characterizing the sugar as L-erythulose. The output of carbon dioxide in relation to the loss of hydroxypyruvate indicates the reaction to be:

$$2\ CH_2OH.CO.COOH \rightarrow CH_2OH.CO.CH(OH).CH_2OH + 2\ CO_2$$

As with pyruvate decarboxylation, the activity is lost on dialysis of the alkaline enzyme-complex, and restored by the addition of cocarboxylase and magnesium ions. Although free glycolaldehyde does not itself yield tetrose, nor does it increase the rate of hydroxypyruvate decarboxylation, free glyceraldehyde can act as an 'acceptor', yielding a ketopentose with these preparations. The possible synthesis of hexose from tetroses and hydroxypyruvate is now being studied, as is also the interesting question of the relationship of these two cocarboxylase-requiring enzymes—carboxylase and transketolase—in the biosynthesis of free sugars from hydroxypyruvate.

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Effect of Size and Age of Female Rats on their Response to the Methæmoglobinogenic Action of 3′-Methyl-4-dimethylaminoazobenzene

During a study of the methæmoglobinogenic activities of various carcinogenic agents, it was observed that a standard dose of the azo dye, 3′-methyl-4-dimethylaminoazobenzene (16·5 mgm. in ~0·55 ml. of arachis oil per 100 gm. body-weight), induced a greater and more persistent methæmoglobinæmia in old female albino rats than in young female rats.

In the experiment given in detail in Table 1, blood was withdrawn from the tails of four non-fasted rats and checked for the absence of methæmoglobin. Most of our normal rats were methæmoglobin-free but a few showed methæmoglobinæmia of a low order (less than 1 per cent). Two hours later each rat received an injection of the azo dye, and blood (~0·2–0·4 ml.) was taken from the tail at 3, 7, 22 and 28 hr. following the injection. Each fresh heparinized blood sample (0·1 ml.) was mixed with Sörensen buffer (10 ml.; *p*H 6·6) and the percentage of methæmoglobin was determined by a modification of the method of Vandenbelt *et al.*[1]. For convenience of handling, the rats were anæsthetized with ether at each bleeding and in the period 7–22 hr. the animals had access to rat cubes and water.

For statistical calculations, the area which the methæmoglobin-time graph makes with the time axis was found to be a convenient measure of the response of the animal. Alternatively, the sum of the methæmoglobin percentages (Σ per cent) at 3, 7, 22 and 28 hr. could be used. Scatter diagrams of methæmoglobin-time (Fig. 1) or Σ per cent plotted against rat body-weight for 13 young and 11 old animals showed strong linear relationships. Correlation coefficients (*r*) of +0·84 were obtained with *t* values of 7·248 and 8·644 respectively, which exceed the 0·1 per cent probability-level. The results are highly significant.

Table 1

Rat		Per cent methæmoglobin at the stated times (hr.) after injection of the azo dye					Methæmoglobin-time (cm.²)
Wt. (gm.)	Age (mon.)	0	3	7	22	28	
245	18	0	16·4	34·5	13·1	6·2	69·7
230	18	0	23·1	32·0	5·7	4·1	57·0
125	2	0	5·9	14·6	2·1	1·5	23·5
125	2	0	4·3	8·2	1·7	1·1	14·1

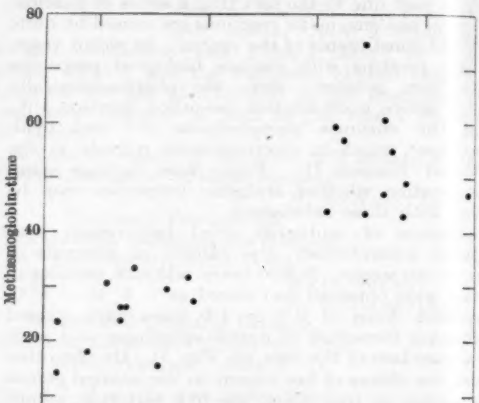

Fig. 1

A complete correlation between methæmoglobin-time and age could not be made owing to uncertainty about the ages of most of the old rats. However, the ages of the young animals were known precisely and a linear correlation was found for this group. Here *r* was +0·61 with *t*=2·521, which exceeds the 5 per cent level and indicates that the result is probably significant. The susceptibility of female rats to the methæmoglobinogenic action of the azo compound appears to increase rapidly during the first few months of life.

Further information about the groups is given in Table 2. From the methæmoglobin-time variance figures quoted there, the best estimates[2] of population variation were found to be 95·459 and 65·961 for the old and young groups respectively. The variance

Table 2

Rat		Age		Body wt. (gm.)		Methæmoglobin-time (cm.²)		
Group	No.	Range	Mean	Range	Mean	Range	Mean	Variance
Old	11	8–18 mon.	—	227–277	245·3	42·9–74·6	52·7	86·781
Young	13	56–72 days	64·7 days	125–175	149·6	5·4–33·4	23·5	60·887

ratio, F, is therefore 1·447 (95·459/65·961), which is lower than the 5 per cent level for 10 and 12 degrees of freedom, so that the difference between the standard deviations of the groups is not significant. Thus "Student's" t may be used for investigating the difference between the sample means. The best estimate for the standard error of the difference of the means was 3·650. Since the difference of the means is 29·255, "Student's" t is 8·015 (29·255/3·650), which greatly exceeds the 0·1 per cent level. Therefore, the difference between the mean values of methæmoglobin-time for old and young groups is highly significant.

It is already known that old rats may exhibit markedly different responses to certain drugs as compared with young animals[2]. It would be of interest to determine whether there is a difference in response of young and old rats to the carcinogenic action of 3′-methyl-4-dimethylaminoazobenzene. Some observations of Druckrey and Küpfmüller[4] suggest that old rats require less 4-dimethylaminoazobenzene than do young rats for liver tumour formation.

Since very little work appears to have been done on the methæmoglobinogenic action of azo compounds, it may be noted here that, mole for mole, 4-dimethylaminoazobenzene has been found to be a more potent methæmoglobinogenic agent for rats than its 3′-methyl derivative. The non-carcinogens, azobenzene, 4′-methyl-4-dimethylaminoazobenzene and 4′-hydroxy-4-dimethylaminoazobenzene, had no methæmoglobinogenic activity, but rats which received the last-mentioned compound succumbed to pulmonary œdema. The non-carcinogen, 4-diethylaminoazobenzene, which also produced pulmonary œdema in rats, gave rise to a transient methæmoglobinæmia.

It has also been found that the methæmoglobinogenic activity of 3′-methyl-4-dimethylaminoazobenzene is suppressed when the carcinogenic hydrocarbon, 20-methylcholanthrene, is incorporated in the azo dye–arachis oil solutions. In these circumstances, the methæmoglobin level in the blood invariably drops during the 3–7 hr. period after injection. Further studies of this effect are in progress because it may be related to other effects which have been observed when methylcholanthrene is given to rats receiving the azo dye, namely, inhibition of liver tumour formation[5], diminution in azo dye binding by liver proteins[6] and increase in amounts of liver enzymes which are able to affect demethylation and azo linkage reduction of 3′-methyl-4-dimethylaminoazobenzene[7].

This work was supported by the Melville Trust, to which my thanks are due. It is hoped to publish a more detailed account later.

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Biological Activity of Benzoxazine-1,3 Derivatives, particularly against Experimental Sarcoma

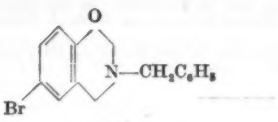
It has already been shown by Šlopek and one of us (T. U.) that 1,3-oxazine derivatives have a marked antituberculous activity *in vivo*. However, those compounds which are derivatives of nitroparaffins and contain a nitro-group show a relatively high toxicity on prolonged administration. This led one of us (T. U.) to look for less toxic derivatives of 1,3-oxazine[2].

Continuing further this line of research, a number of derivatives of benzoxazine-1,3 have been prepared according to Burke[3] and examined from the point of view of their antituberculous activity.

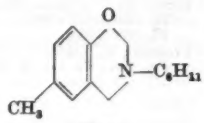
All of them show a tuberculostatic action *in vitro* at concentrations 8–31 mgm. per cent[4].

It has now been found that benzoxazine-1,3 derivatives reduce tumours produced by experimental Crocker sarcoma in mice.

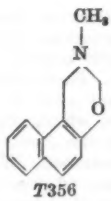
The experiments were carried out by determining the lethal doses when administered subcutaneously. The substances were as follows:



T 339



T 375



T 356

Their lethal and therapeutic doses are given in Table 1.

Table 1

	Concentration (per cent)	Lethal dose for mice of 18–22 gm.	Therapeutic dose
T 339	1·5	30 mgm.	5·0 mgm.
T 375	2·0	5 mgm.	0·2 mgm.
T 356	1·5	10 mgm.	1·2 mgm.

All mice were grafted with Crocker sarcoma. Administration of the drugs subcutaneously was started the day after inoculation. Ten injections of *T* 339 and *T* 375 and eleven of *T* 356 were given during fourteen days. After that, the animals were killed and tumours were examined histologically. The weight of tumours was determined and served to estimate the activity of the drugs.

The results are shown in Table 2.

Table 2

Substance	Total amount of drug (mgm.)	No. of mice		Average weight (mgm.)		Ratio of tumour weights $\frac{c}{e}$
		Experimental ♂ ♀	Controls ♂ ♀	Experimental *e*	Control *c*	
T 339	50	10 —	10 —	855	1,377	1·6
T 339	50	— 10	— 9	1,500	3,093	2·0
T 375	2	8 12	9 10	576	1,441	2·50
T 356	13·2	9 10	9 11	298	944	3·17

It is evident that the substances *T* 375 and particularly *T* 356 inhibit growth of experimental sarcoma tumour. The relatively high toxicity of the substance should, however, be emphasized.

Detailed description of the experiments, including histological examination, will be reported elsewhere.

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Œdema Formation in Rat's Skin

It is known that histamine liberators such as 48/80, egg white and dextran produce in rat skin œdema and capillary changes which lead to accumulation of circulating colloidal dye. These changes show a characteristic distribution and occur in skin regions, such as those of feet and face, which are particularly rich in histamine[1]. However, the part of histamine in these changes has been questioned. When discussing these changes it is necessary to deal separately with the œdema formation and the dye accumulation. The œdema is a sign of greatly increased capillary permeability. Concerning the accumulation of a circulating colloidal dye such as trypan blue, the present concept is that the dye is bound in the bloodstream to plasma proteins which penetrate the dilated capillary wall, moving through the dilated capillaries into the damaged area. The mechanism for this penetration is the phagocytic activity of the endothelial cells, histiocytes and fibriocytes which take up the proteins. The accumulation of circulating dye thus indicates an increased local phagocytic activity. The present experiments show that release of histamine is responsible for the œdema formation but that the accumulation of circulating dye is independent of histamine release.

According to Feldberg and Talesnik[1] the œdema in the feet of the rat produced by intraperitoneal injection of 48/80 or egg white is due to release of histamine, because it no longer occurred when the skin had been depleted of its histamine by repeated intraperitoneal injections of 48/80. In contrast, Kramer[2] found that the histamine content of the rat's skin did not influence the œdema produced by egg white and that the œdema occurred also when the skin had been depleted of its histamine.

Using the technique of Brocklehurst *et al.*[3], rats were treated with intraperitoneal injections of 48/80 for eight days. After treatment for five days 48/80 no longer produced œdema, and after treatment for eight days egg white (2 ml. intraperitoneally) also failed to cause œdema. These results agree with those of Feldberg and Talesnik and differ from those of Kramer. They show that the œdema formation is dependent on the histamine release.

In rats in which the skin histamine had been depleted by repeated intraperitoneal injections of 48/80 and in which injections of histamine liberators no longer caused œdema, intradermal injections not only of histamine and of 5-hydroxytryptamine, but also of 48/80 and of egg white, retained the property of causing accumulation of circulating dye at the site of the injection. Intradermal injections of saline solution were ineffective. The dye used was trypan blue, which was injected into the tail vein immediately after the intradermal injections. The rats were killed 60 min. later and the inside of the abdominal skin examined for local dye accumulation. Similar results were obtained in two other series of experiments in which either the histamine in the rat's skin was depleted by dextran or egg white instead of by 48/80, or in which the trypan blue was replaced by indian ink. These results show that the changes responsible for the accumulation of dye or indian ink are independent of histamine release and therefore not an effect of histamine. A similar conclusion was reached by Brocklehurst *et al.*[3] for the dye accumulation of passive cutaneous anaphylaxis in rats in which the skin had been depleted of its histamine by 48/80.

Indian ink and trypan blue accumulation was not caused by the liberation of histamine or 5-hydroxytryptamine since these latter two substances were no longer present after the first day during repeated treatments with 48/80, dextran or egg white. Even in the absence of histamine or 5-hydroxytryptamine the reaction of accumulation continues, showing an unchanged functioning of the inflammatory defence mechanism.

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Effect of Blood on the Viability of Dried Cultures of Cholera Vibrios

Between 1949 and 1954 twenty-two strains of *Vibrio cholerae*, grown at 37° C. on 'Lemco' agar and suspended in 'Mist. desiccans'[1], were dried by the spin-freeze method developed by Greaves[2]. Viable counts were made by the Miles and Misra[3] technique on the suspensions used for drying, and on ampoules of dried material reconstituted at intervals after drying. In routine tests reconstitution was in 'Lemco' broth, which was also used as diluting fluid. All counts dropped rapidly, thus confirming the experience of others[4,5] that the vibrios were unduly susceptible to drying by sublimation.

Experiment showed that higher viable counts could be obtained (*a*) by using 5 per cent blood broth as diluent, or (*b*) by plating 'Lemco' broth dilutions on blood agar. This suggested that blood provided some essential factor for the recovery of cholera vibrios

Table 1. VIABILITY OF *V. cholerae* (N.C.T.C. 8021) ON 'LEMCO', SERUM AND BLOOD AGAR

	No. of colonies growing at dilutions					
	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}
'Lemco' agar	cc.	11	0	0	0	0
Serum agar	cc.	unc.	29	4	1	0
Blood agar	cc.	cc.	unc.	27	6	0

cc. = confluent colonies. unc. = uncountable

from the dried state, a factor which was not adequately supplied by serum.

It is possible that the population of *V. cholerae* culture is not homogeneous, and that there are cells able to grow on agar and others unable to do so without the addition of blood. To test this point, subcultures were made from the highest dilutions surviving on blood and on 'Lemco' agar and these were redried by the same method. So far there is no evidence to support the theory of a heterogeneous population, but long-term experiments are continuing.

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Coenurus of *Taenia brauni* Setti parasitic in Man and Animals from the Belgian Congo and Ruanda-Urundi

IN 1952 I was able to observe for the first time the life-cycle of *Taenia brauni* Setti (1897).

This tapeworm lives, in the adult stage, in the intestines of dogs and jackals in the Belgian Congo, and its larvæ, of the *Coenurus* type, have been found in Nature in wild rodents (*Lemniscomys striatus* L.).

On feeding laboratory-bred white mice with proglottids found in the droppings of parasitized dogs, I have succeeded in observing the development within them of *Coenurus*. On the other hand, I was successful in obtaining adult worms by feeding non-infected young dogs with fragments of *Coenurus* collected from wild rodents which were naturally infected with the parasite[1].

Afterwards I discovered the *Coenurus* of this tapeworm in numerous other wild rodents in Ruanda-Urundi (*Rattus r. rattus* L., *Tachyoryctes ruandae* Lönnb. and Gyld., *Otomys irroratus vulcanius* Lönnb. et Gyld., *Grammomys surdaster* Thom. et Wroughton, and *Dendromus pumilio lineatus* Hell.) as well as in a monkey (*Cercopithecus mitis doggetti* Poc.) and in man (native). I never found it in sheep or goats nor in the wild rabbit, although this animal is very common in the region.

In wild rodents the *Coenurus* is most often found under the skin; but it may be found also on other parts of the body, namely, in the pleural and abdominal cavities and in the brain. The percentage of infected rats varies very much according to the places investigated, but in certain places it may reach up to 20 per cent of the animals examined.

Cerebral coenurosis of rodents has been found only on three *Rattus r. rattus* in the vicinity of Astrida. These *Coenuri* were rather big and situated in different parts of the brain. Two of the three infected rats had also *Coenuri* on other parts of the body.

The case of cerebral coenurosis of the ape was discovered in the region of the Akanyaru (near Astrida). A globular *Coenurus*, 2 cm. in diameter, was found embedded in the parietal lobe. This ape carried two other *Coenuri*: one, of the size of a large pea, was in part nestled in the apex of the heart; the other, much larger, was found in the region of the parotid gland.

In man (native) I have observed eight cases of coenurosis between the years 1948 and 1956, all situated under the skin. Of these eight cases, seven were children, the ages varying between 11 months and 5 years; the last one was a boy of fourteen.

In four children the tumour was found along the ribs, in the four others it was found elsewhere on the trunk. The *Coenurus* was a solitary one in all patients. The dimension of the tumour varied from the size of an almond to that of a large plum; the form being globular or elongated.

The morphological study of all *Coenuri* showed that they belonged to *Taenia brauni* Setti. This tapeworm is extremely frequent in dogs and jackals throughout the Ruanda-Urundi area and Ituri region (Eastern Congo) and it is, together with *Taenia hydatigena* Pallas, the only cestode of the *Taenia* genus found in the dog of these regions[2].

It is my opinion that the *Coenurus* found by Taramelli and Dubois under the skin of a native woman (of the Belgian Congo) belongs also to *Taenia brauni*[3].

It is known that *Coenuri* of *Taenia serialis* or of *Taenia multiceps*, as parasites of man, occupy on this accidental host the same site as on the habitual intermediary host: respectively under the skin for *Coenurus serialis* and in the brain for *Coenurus cerebralis*.

The larva of *Taenia brauni* is less specific in the choice of its location in its natural hosts than those of the preceding species. It seems to me most probable that it would behave in the same manner in man, and that, besides its normal location under the skin, one may expect to find it in the inner organs as well as in the brain. In this connexion it may be pointed out that, during recent years, four cases of human cerebral coenurosis have been described in South Africa all attributed by the authors to *Taenia multiceps*[4]. It could be that these *Coenuri* belong, in fact, to *Taenia brauni*.

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Histological and Histochemical Observations on the Intestinal Cells of Lambs and Kids absorbing Colostrum

IT has been known for many years that intact colostral globulins are absorbed from the intestine of the young ruminant[1] and recently it has been shown[2], in the calf, that labelled globulins from colostral whey passed from the intestinal lumen into the intestinal lymphatics. Histological examination of

the intestinal epithelium of calves in which absorption of protein was taking place revealed the presence of numerous globules with similar staining properties to the protein of the whey, and hence it was suggested that the protein, which was absorbed without change, passed through the cells of the epithelium of the small intestine[3].

We have recently carried out a histological and histochemical study of the intestinal epithelium of young lambs and kids which were killed shortly after receiving colostrum. As in the calf, the epithelial cells of the villi of animals up to 36 hr. old contained large numbers of eosinophilic globules of varying size (2·5–15μ), while the cells of older animals did not contain globules. The globules were present throughout each cell, the majority occupying an infranuclear position since most of the nuclei were close to the free border of the cell.

As described by Comline *et al.*, colostral whey with similar staining and histochemical properties to the globules was present in the lumen of the gut and between the intestinal villi. In this position the whey was in a finely granular form. Moreover, finely granular material with similar staining and histochemical properties was demonstrable in the lacteals within the villi. Examination of suitably stained sections (periodic acid – Schiff) revealed numerous small granules just within the free border of each epithelial cell. These granules had similar staining properties to the globules and hence it appeared that the material in the lumen of the intestine was absorbed in a finely divided form and that globule formation occurred within the cell. Although in mounted paraffin sections the globules appeared homogeneous, examination in water of sections stained with methylene blue revealed that each large globule was made up of a number of smaller globules. Breakdown of the globules apparently occurred within the cell since none could be demonstrated in the lacteals.

Table 1

Histochemical test	Lumen content	Globule	Lacteal content
Periodic acid – Schiff (PAS)	+	+	+
PAS after diastase	+	+	+
PAS after hyaluronidase	+	+	+
Metachromasia	–	–	–
Methylene blue extinction	Faint or nil below *p*H 4·0	Faint or nil below *p*H 4·0	Faint or nil below *p*H 4·0
Alcian blue	–	–	–
Sudan III and IV	+	–	+
Sudan black *B*	+	–	+
Nile blue sulphate	+	–	+
Millon reaction	+	+	Faint +
Feulgen reaction	–	–	–
Pyronin	+	+	+
Pyronin after ribonuclease	+	+	+

The results of the histochemical tests are presented in Table 1. They showed that the material in the lumen of the gut, the globules in the epithelial cells and the material in the lacteals was muco- or glycoprotein. It seems reasonably certain, therefore, that the globules were, in fact, the colostral proteins. That the protein was present as a conjugated protein was not unexpected since highly purified preparations of colostral globulin have been shown to contain residual carbohydrate material[4,5], and fractions of serum globulin have also been shown to fall into the group of glycoproteins[6]. It is possible, however, that the colostral globulin became associated with the mucus secreted by the digestive tract prior to absorption. This point is being investigated.

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Tracheæ of *Acheta domesticus* Linn.

We have recently been examining the testes of *Acheta domesticus* Linn. in the electron microscope (Siemens Elmiskop 1), using osmium-fixed ultra-thin

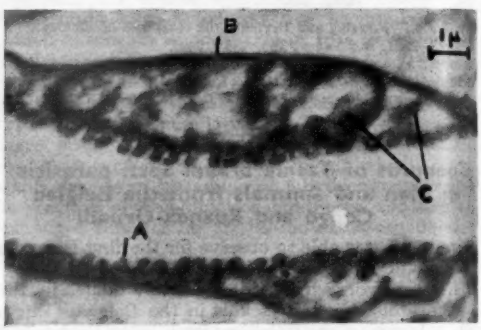

Fig. 1. Longitudinal section approximately through the long axis of a trachea

Fig. 2. Longitudinal section through the 'endocuticular' folds of a trachea.

sections of about 250 A. In the course of this work we have made a number of observations on tracheæ which supplement earlier findings[1–5]. Fig. 1 shows a longitudinal section of a trachea which appears to consist of a folded 'endocuticular' layer (*A*), and an 'exocuticular' layer (*B*) which surrounds both the trachea and the accompanying cell (*C*). Fig. 2 shows a section through the 'endocuticular' folds. The 'endocuticular' layer itself is about 100 A. thick. The folds are ring-like or possibly helical, and are separated from each other by a few thousands of angstroms. The 'exocuticular' layer is also about 100 A. thick.

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Terminology of the Insect Integument

A worker proposing to investigate the covering layers of the Insecta quickly finds that he has to contend with a confused and often contradictory terminology. This state of affairs derives from three principal sources: a detailed knowledge of the coverings has become possible only through technical advances made over the past thirty or so years; students have frequently accepted, rather uncritically, the older terminology; and, as yet, relatively little is known of the coverings throughout the class, and the necessary homologies on which a standard terminology must be founded are therefore wanting.

While these are undeniable facts, it is equally undeniable that unless some action is taken, confusion will be augmented as time goes on. Moreover, there are sufficient, even though elementary, data on which to base a consistent terminology, simple yet capable of expansion to meet future needs. To be acceptable such a terminology demands that the introduction of new terms be minimized, and that those which are well established be clearly defined, or, if necessary, re-defined to avoid ambiguity.

The term 'integument' as denoting the unicellular layer with its internal limiting membrane and its outer secreted covering is now in general use. 'Basement membrane' is also the standard term for the internal bounding membrane of the cellular layer. For the latter, 'epidermis' and 'hypodermis' are about equally popular. Indicating as it does the location of the cellular layer with reference to the secreted part of the integument, and being used in a less general sense than is 'epidermis', 'hypodermis' could well be accepted and 'epidermis' dispensed with.

To all entomologists the external secreted part of the integument is known as the 'cuticle'. The value of this term has to some extent been lessened by the choice of 'epicuticle' for the thin outer non-chitinous part of the cuticle. However regrettable this may be, it is now too late to effect any change. For the larger inner chitinous part of the cuticle, the 'procuticle' of Richards[1] appears to be the only term yet proposed, though it has not attained the currency it merits.

Both procuticle and epicuticle consist of zones variable in number, size, and composition. The only consistent terminology for the procuticle is that of Richards[1] including the modification of Schatz[2] which Richards[3] accepts. He regards the procuticle as consisting of from one to three zones. He restricts the term 'exocuticle' to the hardened part of the cuticle, commonly amber, brownish or black in colour, which is both impregnated and sclerotized. The 'mesocuticle' is that part which is impregnated but not sclerotized, and which is stained by acid dyes, for example, the acid fuchsin of Mallory's stain. The 'endocuticle' is that part of the cuticle which remains chemically unchanged after it has been deposited. This terminology is used in the United States, on the Continent, and in Australia, and it is to be hoped that its adoption eventually becomes general.

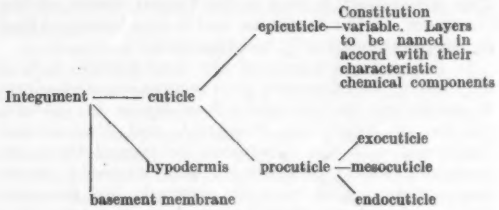
It is the terminology of the least-known part of the cuticle, the epicuticle, that is most unsatisfactory. Wigglesworth distinguished four layers in the epicuticles of *Rhodnius*[4], *Tenebrio*[5], and *Periplaneta*[6]. Beginning with the outermost, he named these the 'cement', 'wax', 'polyphenol', and 'cuticulin' layers respectively. Following his example, his followers have exercised considerable ingenuity in interpreting the epicuticles of the insects they have studied in terms of this system. Wigglesworth's terminology was not accepted by Richards[1] nor Dennell and Malek[7,8]. As a result of their work, Dennell and Malek accepted the presence of the cement, wax and cuticulin layers but considered the evidence for the presence of a distinct polyphenol layer insufficient. In place of it they claim that there is a thin 'paraffin' layer. While this is the most recent authoritative pronouncement on the subject, it must still be accepted with reserve. Even among the relatively few species which have been adequately studied, there is a considerable proportion of the epicuticular layers which cannot be homologized in accord with any one proposed scheme. Richards outlined a terminology similar in some respects to that of Dennell and Malek. He proposed the substitution of the term 'tectocuticle'[1] for the earlier 'cement layer' on the grounds that the use of 'cement' in this manner was contrary to histological practice. His term is unfortunate since it suggests the presence (not intended by Richards) of a third major division in the cuticle. Further, he does not propose to use it in the strict sense that 'cement layer' is used, for he himself points out (p. 170) that his term can apply equally to the thin outer protecting layer overlying a wax layer as in *Rhodnius* and *Tenebrio* (that is, as a synonym for 'cement layer'), to the wax layer of the Aleurodidae, to the secretion of the 'peristigmatic' glands of insects, and to the grease layer of ixodid ticks. Obviously, such a term is too general to have any value. Whatever its demerits, the term 'cement layer' is innocuous and non-committal, and as used by Wigglesworth and Dennell and Malek refers only to the thin external layer which overlies the wax layer in a four-layered epicuticle.

In the present state of our lack of knowledge, nothing can be a greater hindrance to progress than an attempt to erect a rigid terminology for the epicuticle. The wisest course to follow is to begin the study of each species with a minimum of pre-conceived ideas as to the constitution of its epicuticle, to determine the number and composition of its layers as found, and to name these according to their

characteristic chemical components. This was Dennell's method in dealing with *Sarcophaga*[9] and no better has yet been suggested. Such a method will eventually accumulate data sufficiently comprehensive for precise generalizations to be made.

Finally, a term is needed for the 'skin' shed by an immature insect when it moults. 'Exuviae' is a Latin plural having no singular form. The word itself is ugly, and the various singular forms coined from it are even more so, as well as being etymologically indefensible. None of these is accepted by anyone except its user. Until a generally acceptable term is proposed my own practice is to use the words 'slough' and 'sloughs' with their ordinary English signification.

Based on what has been said above, the following system of terminology is presented for consideration:



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Sept. 21.

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Gibberellic Acid and the Growth of Crop Plants

Gibberellic acid has been found to increase the height of a wide variety of plant species in small-scale experiments[1,2]. We summarize here the results of larger-scale experiments on crops growing in the field which began in July 1953 and continued for the next three years.

Preliminary work showed that 2 oz./acre of gibberellic acid in 100 gallons of water was the optimum rate of application, and this was afterwards used in most of the randomized and replicated plot experiments. Lower spray-rates and dust applications were less effective. Four to ten weeks after treatment each plot was cut, the grass weighed and sampled for dry weight and crude protein (total nitrogen) determinations.

The experiments were carried out on varied swards at four different centres. Nevertheless they all gave basically similar results. Gibberellic acid increased the growth-rate of all components of the swards. Dicotyledons had longer internodes and petioles, while grasses produced longer, though narrower, leaves. These effects were observed even under conditions when there was little or no response to fertilizer alone. Typical dry-weight yield increases are shown in Table 1. The considerable variations were not unexpected, because of differences in the nature of the experimental sites, the grass species, the prevailing weather conditions and the length of time between treatment and cutting. The nitrogen content of the grass was lowered by about 2 per cent after treatment with gibberellic acid, so that the yields/acre of crude protein were not increased to the same degree as the dry-weight yields.

The initial growth response to gibberellic acid was more rapid than that to nitrogenous fertilizers. The difference persisted longer in the spring and autumn, when the natural growth was slow, than at other times of the year. Eventually, however, the yields obtained with fertilizers became greater than those obtained with gibberellic acid. For example, in the spring, 2 oz./acre of gibberellic acid and 2 cwt./acre of fertilizer gave approximately the same increased yields if the grass was cut within five weeks of treatment; but if the cut was delayed longer, the increases obtained with fertilizer were up to three times those obtained with gibberellic acid.

The increase of growth obtained after treatment with gibberellic acid was accompanied by a temporary chlorosis of the grass. The normal green colour returned within six to eight weeks, or, if a nitrogenous fertilizer was applied together with the gibberellic acid, within a much shorter time. The yield increases given by gibberellic acid and fertilizer, applied together, were additive.

If, after cutting, the grass was allowed to grow again without further treatment with gibberellic acid, the dry matter and crude protein yields at a second cut were depressed by approximately the amount of the increase at cut 1 (Table 1). Consequently, the total yield over the two cuts was not significantly

Table 1. Differences in the Dry-weight Yields of Grassland at Two Cuts following Treatment with Gibberellic Acid

Date of treatment	Dry weight yields at cut 1			Dry weight yields at cut 2		
	Untreated control (cwt./acre)	Increase due to 2 oz./acre gibberellic acid (cwt./acre)	Increase as percentage of control	Untreated control (cwt./acre)	Decrease due to initial gibberellic acid treatment (cwt./acre)	Decrease as percentage of control
March 1, 1955	19·8	3·1	16	30·8	3·9	13
,, 4, 1955	12·2	4·0	31	13·5	3·0	22
,, 14, 1955	29·8	4·3	14	29·2	3·7	13
,, 18, 1955	9·1	3·9	43	13·2	2·4	18
,, 18, 1955	11·3	1·6*	14	16·7	2·0	12
April 13, 1955	25·1	5·0	20	30·3	7·0	23
,, 13, 1954	17·1	7·9	46			
,, 13, 1954	19·3	6·4	33	40·0	9·9	25
July 10, 1953	15·4	4·1*	27	4·4	0·5*	11
August 5, 1954	21·8	1·2	6			
,, 18, 1954	22·9	3·2	14			

All differences, except those marked with an asterisk, were significant at the 1 per cent level.

increased. There were no significant differences at subsequent cuts.

The causes of the reduced growth-rate after the first cut are not fully understood. Depletion of soil nutrients by initial rapid growth is unlikely to be a factor, since application of fertilizer between the cuts had no effect. There was, however, more bare ground on the plots treated with gibberellic acid than on the controls after the first cut, which would indicate that a greater proportion of top growth, particularly of clovers, was removed. This may have checked the re-growth[3]. On the other hand, large decreases of yield at cut 2 were occasionally obtained when the increase at cut 1 was small. This suggests that gibberellic acid had some direct influence on re-growth. It did not, however, cause any permanent change in the composition of the sward.

Experiments on arable crops showed that greater growth of aerial parts of the treated plants was not accompanied by increases in crop yields. For example, wheat treated in the early spring showed a rapid initial increase in growth-rate, but the grain and straw yields at harvest were not greater than those of untreated plants. Similarly, the crop size of tomatoes, peas, runner beans and blackcurrants was not increased when the plants were sprayed with gibberellic acid during flowering or early fruit-set, in spite of a marked increase in the vegetative growth. In other experiments the yield of root crops, including potatoes, turnips and carrots, was even decreased in spite of stimulation of the growth of the tops.

If gibberellic acid could be used in practice for the production of early- and late-season grass, it would be of interest to the dairy farmer only where conditions allow the herbage to be used efficiently. It is difficult to assess the economic return from extending the growing season in this way, particularly since the total yields from swards treated with gibberellic acid are not increased. The use of gibberellic acid in grassland practice seems unlikely.

A fuller account of this work is being prepared for publication elsewhere.

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Action of Day-length upon the Formation of Adventitious Buds in *Bryophyllum tubiflorum* Harv.

In recent experiments I have found that day-length strongly influences the formation of adventitious buds in *Bryophyllum tubiflorum* Harv.

Two series of young plants were selected: one was grown during short days (8 hr.), the other during long days (16 hr.), in an ordinary greenhouse in summer. The plants of the two series grew normally; however, progressively, the 8-hr. plants began to differ from the 16-hr. plants in two principal respects: (1) their stems and leaves remained somewhat smaller; (2) already in the first months of culture, the former were totally unable to produce new adventitious buds, whereas in the same time, the long-day plants produced a great number of such buds.

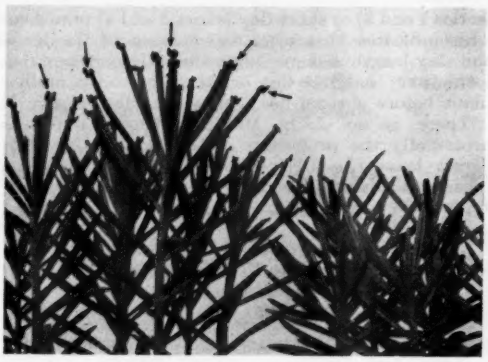

Fig. 1. Adventitious buds on *Bryophyllum tubiflorum* Harv. leaves after 4-month culture. Left, 16-hr. plants; right, 8-hr. plants. Only the long-day plants produce buds (arrows)

The situation became still more marked during the following months until the end of the experiment (4 months): only the leaves of the 16-hr. plants had initiated adventitious buds (Fig. 1).

It could be demonstrated that this effect is related to differences in the internal properties of the leaves of the two kinds of plants, caused by the day-length they had received. This is particularly evident in the following experiment.

After 4 months culture, all the leaves were removed from the 8-hr. and 16-hr. plants and placed horizontally on a moistened sand surface. The culture was placed in an ordinary greenhouse in summer with sufficient humidity. One series of leaves were subjected to long-day treatment, and the other to short-day treatment. Thus four series were formed: (1) leaves taken from long-day plants and given long-day treatment; (2) leaves taken from long-day plants and given short-day treatment; (3) leaves taken from short-day plants and given long-day treatment; (4) leaves taken from short-day plants and given short-day treatment.

Only the long-day leaves (series 1 and 2) were able to produce new adventitious buds; these buds were normally situated at the apical end. At the same time, the short-day leaves (series 3 and 4) remained incapable of initiating such buds. However, after one month of culture on moistened sand, these short-day leaves began to develop a certain number of young buds at their basal end, where the long-day leaves had produced very few after several months.

It should be noted that the result was the same when the separated leaves were given either long-day

Table 1. Effect of Day-length upon Bud Formation by *Bryophyllum* Leaves. Number of Buds made by 50 Cut Leaves per Series, in a Period of Three Months

Series	*Bryophyllum* mother-plants cultivated in:	Cut leaves placed in:	No. of apical buds	No. of basal buds
1	16 hr.	16 hr.	63	6
2	16 „	8 „	57	5
3	8 „	16 „	9	18
4	8 „	8 „	0	11

(series 1 and 3) or short-day (series 2 and 4) treatment. This indicates that after the cutting of the leaves the day-length has no noticeable action upon bud formation; only the day-length given to the mother-plant before cutting has a decisive effect (Table 1).

There is no doubt that day-length influences profoundly the properties of the *Bryophyllum tubiflorum* leaves, modifying specially their polarity in regard to adventitious bud formation.

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Biosynthesis of Citric Acid in Citrus Fruits

No detailed study has so far been made to find out the mechanism of the formation and accumulation of citric acid in citrus fruits even though studies on the change of acidity and *p*H during ripening have been reported[1]. Investigations are in progress in this laboratory to study the biosynthesis of citric acid in citrus fruit (*Citrus acida*), as a preliminary to which an attempt has been made to locate the stage during the growth of citrus fruit at which citric acid can be detected. The results of the investigation are recorded here.

Fruits used in this investigation were obtained from a plot of thirty trees from a citrus fruit farm. A large number of fruit buds, all of 0·4 cm. diameter, were selected for the investigation, and at different stages of their growth fruits were removed and analysed for acidity and citric acid content. Chromatographic studies were also carried out to detect the different organic acids present.

The samples of the fruit were collected fresh from the trees, the outer skin removed, and a known weight of the tissue immediately homogenized in a Waring blendor for 3–4 min. with a minimum known amount of water. An aliquot of this homogenate was filtered through a funnel and this filtrate made up to a known volume. The filtrate was then suitably diluted and the free acidity estimated by titrating against standard sodium hydroxide using phenolphthalein as indicator. The citric acid was estimated by the method of Saffran and Denstedt[2]. The results are expressed as percentages of total dry weight of the samples taken. Fig. 1 shows the changes in free acidity and citric acid content at different stages of development of the fruit.

The concentrated samples of the filtrates were chromatographed to detect the presence of different organic acids. Descending one-dimensional paper chromatography with Whatman No. 1 filter paper

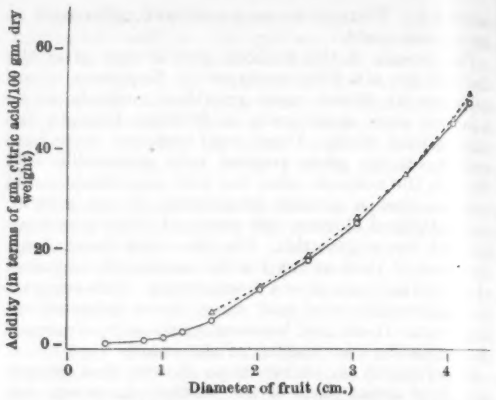

Fig. 1. Δ —— Δ, Citric acid; O —— O, free acidity

was used for this purpose. The solvent employed was a mixture[3] of butanol, formic acid and water in the ratio of 5 : 1 : 4. The developed chromatogram was sprayed with bromocresol purple reagent. The chromatogram is shown in Fig. 2.

It is clear from the chromatogram that in the case of fruits having a diameter of 1·5 cm. and greater, citric acid is the predominant acid with small amounts of malic acid, whereas at younger stages of growth succinic acid is the predominant one with small amounts of two other acids (x_1 and x_2) which are yet to be identified. This shows that the fruit tissues are specialized tissues regarding the formation and accumulation of citric acid and that they are different from those of leaves or stems where citric acid is detected at all stages of their growth (unpublished results). Further, citric acid formation and accumulation in fruits may not be due to translocation from the leaves but to the conversion of sugars into acids by

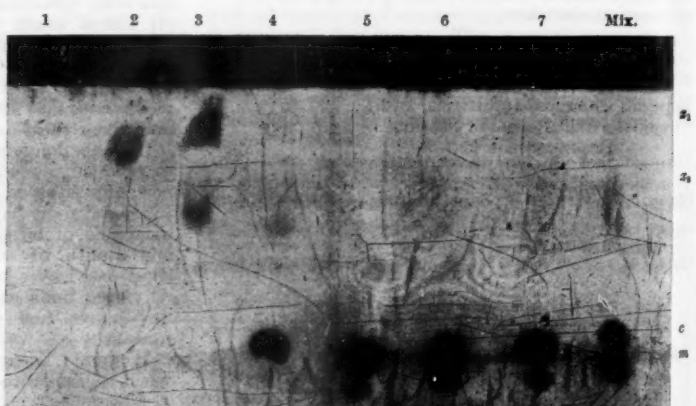

Fig. 2. Chromatogram showing different organic acids present at various stages of development of citrus fruit. Mix. = standard mixture consisting of citric, malic and succinic acids; 1 = 0·4 cm.; 2 = 0·8 cm.; 3 = 1·2 cm.; 4 = 1·5 cm.; 5 = 2·5 cm.; 6 = 3·5 cm.; 7 = 4·4 cm.-diameter fruit extracts

the enzyme system present in the fruit tissues. Details will be published elsewhere.

Our thanks are due to the authorities of the University for financing this project and for the award of a research assistantship to one of us (T. N. S. V.). Our thanks are also due to B. N. Patel and Sons for the generous supply of citrus fruits and to Dr. V. G. Pathak and Mr. Y. K. Sane, of the Botany Department, for taking the photograph of the chromatograms.

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Aug. 27.

[1] Sinclair, W. B., and Eny, D. M., *Bot. Gaz.*, 107, 231 (1945).
[2] Saffran, M., and Denstedt, O. F., *J. Biol. Chem.*, 175, 849 (1948).
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Dormancy in Barley

A recent communication[1] suggests that high results in germination tests on barley, carried out in moist sand for 7–10 days, necessarily indicate the absence of 'dormancy' in the sample. It further claims that the 'dormant' condition in barley can be eliminated by desiccation.

The purpose of the present communication is to point out that a live barley corn must be regarded as 'dormant' if conditions can be found under which it fails to germinate but which permit the germination of fully mature grain. A convenient test which meets the latter requirement is as follows[2]: Two filter-paper circles (9·0 cm. diam.; Whatman No. 1 or No. 29) are firmly flattened into the bottom half of a Petri dish (4 in. diam.). The papers are next wetted evenly with water (4 ml.) added from a pipette or burette. One hundred corns of the sample to be examined are then added in such a way that each corn makes full contact with the moist paper. The covered dish is kept in the dark at 18° C. The final count is made after 72 hr.

The result obtained in this test is referred to as the 'germinative energy' of the sample. In the case of a fully mature sample not only is this high but the result is not affected by varying within wide limits the quantity of water available[3]. Less mature barleys frequently respond adversely to increases in the amount of water present during germination and such barleys are termed 'water-sensitive'.

On the above basis, a barley may have low germinative energy[4] even though most of the corns germinate in the prolonged test described by Wellington[1]. Moreover, even if its germinative energy be high, a barley may still prove to be 'water-sensitive' and so appear 'dormant'. For example, in material which had been rigorously dried for seven days at 40°–24° C. and then stored for eighteen days, only 56 per cent of the corns germinated in a water-sensitivity test[3] even though the germinative energy was 95 per cent. Indeed, although it is recognized[5] that desiccation has a marked influence on the 'rate' of disappearance of dormancy in barley during subsequent storage, it is my experience that drying by itself is almost invariably insufficient to convert a dormant barley into a fully mature one.

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[1] Wellington, P. S., *Nature*, 178, 601 (1956).
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[5] Essery, R. E., and Pollock, J. R. A., *J. Inst. Brew.*, 62, 327 (1956).

When applied to germination, 'dormancy' and 'maturity' are not precise terms, and their meaning therefore depends on the particular test which is used. The data in my communication[1] relate to tests in which the conditions were optimal, in all respects, for the germination of barley grains. Complete germination was obtained immediately after the drying treatment, and must necessarily be attributed to the removal of inherent dormancy in the grains which would not otherwise germinate. There is the further significant fact that this response was not only obtained during storage after harvest, but also when the grains were ripening, and at the harvest-ripe stage.

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[1] Wellington, P. S., *Nature*, 178, 601 (1956).

A New Species of *Branchiocerianthus* from a Norwegian Fjord

A specimen of the remarkable hydroid genus *Branchiocerianthus* was caught on July 6, on muddy sand at about 210–240 m. depth in the inner part of the Hardangerfjord on the Norwegian west coast. Previously this genus was known only from the Pacific (Japan, northern Pacific, Gulf of Panama), the Indian Ocean (Somali coast, coasts of Oman and Baluchistan), the Mediterranean (Naples), and the Atlantic (Davis Strait). The new record is thus the first from the eastern Atlantic.

The measurements of the specimen were taken after it had been fixed; but as it did not contract when alcohol was gradually added to the sea water, the measurements are probably valid also for the living animal.

The specimen is apparently fully grown. The hydrocaulus is 110 mm. long and about 2 mm. in diameter, ending below in a small bulb with numerous filaments. The hydranth is diskiform and has the outline of a tennis racket. Its longitudinal diameter is 9 mm., its transverse diameter about 7·5 mm. It is very distinctly bilateral and is attached to the hydrocaulus by its pointed ventral end.

Along the margin of the hydranth are found 54 filiform proximal tentacles. The whorl is interrupted ventrally. The tentacles at the broadest part of the hydranth are about 65 mm. long, the dorsal ones about 30 mm. Towards the ventral margin the tentacles grow gradually shorter, the shortest being almost microscopical.

From the distal third of the hydranth the hypostome emerges. It is about 5 mm. high and ends in numerous filiform distal tentacles 4–5 mm. long, around the transversally placed mouth opening. These tentacles

stand in several rows, and are so crowded that it is impossible to count them without destroying the animal; but the number has been estimated at about 50–60.

Between the proximal tentacles and the hypostome, thirty-four blastostyles (four of which are fused) were found, arranged in horseshoe-shape, the row being interrupted ventrally. The smallest blastostyles are situated nearest to the hydrocaulus, the largest ones laterally and dorsally, where they are arranged in two rows. The blastostyles are dichotomously branched and each end branch has the shape of a cluster of grapes.

The colour is pale pink, the blastostyles being pale salmon-red.

Between the blastostyles and the marginal tentacles unbranched radial canals are seen through the transparent wall of the disk. This proves that the specimen is a *Branchiocerianthus* and not a *Branchiaria*. Apart from the radial canals, nothing is known of the internal anatomy; but the external morphological characters alone reveal that the specimen cannot be referred to any of the *Branchiocerianthus* species hitherto described, namely, *B. imperator* (western and northern Pacific, Indian Ocean), *B. urceolus* (Gulf of Panama) and *B. reniformis* (Davis Strait). Nor can it be identical with the underscribed *B. italicus* (Naples), which has a colouring very different from that of our specimen. The Norwegian *Branchiocerianthus* thus undoubtedly belongs to a new species, which has been given the name *B. norvegicus*.

A more detailed description of this interesting form will be given elsewhere.

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Potassium–Argon Dating of Plio-Pleistocene Intrusive Rocks

The potential of the potassium–argon technique in the dating of young rocks can be evaluated by applying it to intrusive igneous rocks which are well dated by conventional geological methods. Because of their possible interest, we are reporting the dating of two such igneous rocks. They occur at Sutter Buttes in the Sacramento Valley, forty miles north of Sacramento, California. Rhyolite plugs of Plio-Pleistocene age intrude and upturn sedimentary formations of late Cretaceous to early Pliocene age. Erosion uncovered the rhyolite plugs before the ensuing period of andesitic intrusions and extrusions, suggesting that the entire igneous cycle covered many thousands of years. Canyons 1,500 ft. deep have since been incised in the sedimentary complex, and much of the volcanic debris which once covered the area to a depth of 500 ft. or more has been stripped by erosion during the time since igneous activity ceased. One of the rhyolite plugs and the youngest andesite block-lava flow were dated. Biotite was used for the age determinations, essentially pure concentrates being obtained by bromoform and diiodomethane methods. Tyler mesh sizes were −35+150. A branching ratio of 0·110 and a decay constant of $0{\cdot}558 \times 10^{-9}$ gm. were used. The pertinent age data are given in Table 1.

Table 1

Number	Rock	Mineral	Weight (gm.)	K (%)	^{40}A (10^{-10} moles)	Age (10^6 yr.)
KA 101	Sutter Buttes andesite flow	Biotite	16·696	4·04	1·78	1·57 ± 0·24
KA 65	Sutter Buttes rhyolite plug	Biotite	18·734	6·61	3·53	1·69 ± 0·10

The radiogenic ages are thus in agreement with a Plio-Pleistocene age for the rocks and actually place them in the correct order. However, it must be pointed out that, within the errors of the experiment, the ages are the same. Because of the small fraction (0·08) of argon-40 which is radiogenic in *KA* 101, a 1 per cent error in the determination of the $^{36}A/^{40}A$ ratio gives rise to a 12·5 per cent error in the age. This error in the $^{36}A/^{40}A$ ratio arises from mass discrimination effects in the spectrometer and from limitations on the accuracy of measurement of the argon-36 peak. In future runs, we will attempt to minimize the influence of these factors by running a normal air-argon sample in the spectrometer immediately after the rock-argon, and by more sweeps (twenty-five) on the spectrometer. This work was supported by the Atomic Energy Commission.

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Lavoisier's Laboratory Note-books

In the review of the first part of the *Correspondance* of Lavoisier in *Nature* of November 17, p. 1081, it is said that "M. Fric has also traced the missing volume of Lavoisier's note-books". This is based on a statement in the book reviewed. The second volume of Lavoisier's laboratory note-books is still sometimes said to be missing, although its location was pointed out in 1902 by Brocard in the *Comptes Rendus*[1]. It is *MS.* 61, *ancien* 59, in the library of Perpignan and was presented by Arago, who has written on the cover: "offert respectieusement à la Bibliothèque publique de la ville de Perpignan, par F. Arago". Arago, the distinguished physicist, was born in Perpignan. The document consists of 122 leaves, covering the period September 9, 1773, to March 5, 1774, and a note by Arago says: "Ce cahier renferme les célèbres experiences sur la calcination des métaux en vases clos, et les premières tentatives de Lavoisier sur le combustion du diamant". In the same note, Brocard gives a list of libraries in France containing documents by Lavoisier. Brocard's note seems to have been overlooked, but my attention was directed to it many years ago by the late Dr. Max Speter, who had an unrivalled knowledge of Lavoisier. M. Fric promises to publish the document in full "some day"; a summary only of its contents was given by Berthelot[2].

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[1] *C.R. Acad. Sci., Paris*, **135**, 574 (1902).

[2] *C.R. Acad. Sci., Paris*, **135**, 549 (1902), mentioning Brocard.

FORTHCOMING EVENTS

Monday, December 17

INSTITUTE OF METAL FINISHING (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 5.30 p.m.—Annual General Meeting. 6.15 p.m.—Mr. D. R. Newman and Mr. J. E. Entwhistle on Mr. L. Edridge: "Metal Cleaning".

ROYAL GEOGRAPHICAL SOCIETY (joint meeting with the ALPINE CLUB, at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Mr. Albert Eggler: "Swiss Ascent of Everest and Lhotse".

Tuesday, December 18

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. Andrew Young, Mr. H. A. Longden and Mr. B. L. Metcalf: "Post-War Developments in the Coal Mining Industry".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Breakdown in Dielectrics", opened by Mr. C. G. Garton and Mr. J. H. Mason.

INSTITUTION OF MECHANICAL ENGINEERS, INDUSTRIAL ADMINISTRATION and ENGINEERING PRODUCTION GROUPS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Case Studies from the Application of Planned Maintenance".

Wednesday, December 19

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Mr. G. N. Plass: "The Influence of the 9·6 Micron Ozone Band on the Atmospheric Infra-red Cooling Rate"; and "The Influence of the 15 Micron Carbon-dioxide Band on the Atmospheric Infra-red Cooling Rate"; Mr. P. Hughes: "A Determination of the Relation between Wind and Sea-surface Drift".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.15 p.m.—Prof. M. S. Bartlett: "Measles Periodicity and Community Size".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. N. H. Hartshorne: "Some Applications of Polarization Microscopy".

BRITISH PSYCHOLOGICAL SOCIETY, MEDICAL SECTION (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 8.30 p.m.—Mr. John H. Hambling: "The Psychology of High Blood Pressure".

Thursday, December 20

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Birdcage Walk, London, S.W.1), at 10 a.m.—All day Section Lecture on "Transonic Wind Tunnel Testing Techniques".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. H. C. Curwen: "A Field Method for the Rapid Estimation of the Oxides of Niobium and Tantalum in Black Sand Concentrates"; Mr. P. I. A. Narayanan and Mr. G. V. Subramanya: "Laboratory Studies on the Beneficiation of some Ferruginous Manganese Ores of India for the Production of Ferromanganese".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

RESEARCH WORKER (with a medical or biological qualification and some research experience) to assist in the investigation of the minute structure and development of nervous and other tissue, including densitometry and electron microscopy—Prof. G. Causey, Department of Anatomy, Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2 (December 19).

ASSISTANT EXPERIMENTAL OFFICER (male, preferably with a degree in chemistry, botany or agriculture and experience of the analysis of radioactive materials, or at least G.C.E. (advanced level) with two scientific subjects) IN THE RADIOBIOLOGICAL LABORATORY, for duties which include the analysis of biological samples for radioactive isotope content and associated field work—The Secretary, Agricultural Research Council Field Station, Compton Newbury, Berkshire (December 22).

LECTURER (with a degree in mathematics and teaching experience) IN THE MATHEMATICS DEPARTMENT—The Registrar, The Technical College, Sunderland (December 22).

SENIOR LECTURER IN THE DEPARTMENT OF MATHEMATICS; SENIOR LECTURERS (2) IN THE DEPARTMENT OF PHYSICS; SENIOR LECTURER and a LECTURER IN THE DEPARTMENT OF METALLURGY—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (December 22).

TECHNICAL ASSISTANT (with Inter.B.Sc. or equivalent, and preferably previous experience) at the Central Laboratory, Chiswick, for chemical work—The Recruitment and Training Officer (F/EV. 598), London Transport, 55 Broadway, London, S.W.1 (December 22).

ASSISTANT ENGINEER (with a degree in a scientific subject, and keenly interested in the application of scientific methods of research to the solution of industrial problems) IN THE OPERATIONAL RESEARCH SECTION at Headquarters, London, S.E.1—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting Ref. A.E.940 (December 27).

CHIEF LABORATORY TECHNICIAN (male, with wide experience of laboratory work, and able to produce evidence of administrative capabilities and experience), for duties which include the general overall supervision of laboratory technicians, responsibility for laboratory service units and stores, and the care and maintenance of laboratory equipment—The Secretary, Research Institute (Animal Virus Diseases), Pirbright, Surrey (December 31).

LECTURER IN ENGINEERING (CIVIL)—The Registrar, The University, Manchester 13 (December 31).

LECTURER IN THE DEPARTMENT OF PHYSICS, Queen's College, Dundee—Joint Clerk to the University Court, The University, St. Andrews (December 31).

PRINCIPAL (with high academic qualifications and appropriate educational and administrative experience in a University College or Technical College)—The Clerk to the Governing Body, Woolwich Polytechnic, London, S.E.18 (December 31).

RESEARCH ASSISTANT IN THE DEPARTMENT OF CHEMISTRY, for work on the fundamental chemistry of grass conservation—The Secretary, The University, Edinburgh (December 31).

RESEARCH MICROBIOLOGIST IN THE DOMESTIC FOOD PRESERVATION SECTION, Long Ashton Research Station—The Registrar and Secretary, The University, Bristol (December 31).

HEAD (with high academic qualifications and considerable statistical experience) OF THE STATISTICS SECTION of the Rubber Research Institute of Malaya at Kuala Lumpur, for duties which will include the design of field and laboratory experiments and the conduct of research in statistical matters relating to all branches of the Institute's work—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (January 1).

LECTURER IN EXPERIMENTAL PHYSICS—The Registrar, The University, Liverpool (January 2).

LECTURER IN EDUCATION at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 4).

RESEARCH OFFICER or SENIOR RESEARCH OFFICER (with a university honours degree in science or agricultural science or equivalent qualifications with entomology as a major subject, and preferably with research experience) IN THE DIVISION OF ENTOMOLOGY, Commonwealth Scientific and Industrial Research Organization (Commonwealth of Australia), to take part in investigations into the biological control of skeleton weed, *Chondrilla juncea* L.—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 180/116 (January 4).

ASSISTANT LECTURER or LECTURER (with special interests in general or inorganic chemistry) IN CHEMISTRY—The Registrar, The University, Sheffield (January 5).

SUPERINTENDENT (science graduate) OF THE CHEMISTRY LABORATORIES—The Registrar, The University, Sheffield (January 7).

ASSISTANT LECTURER or LECTURER (preferably with special qualifications and interests in mineralogy and petrology) IN GEOLOGY—The Registrar, University College of North Staffordshire, Keele, Staffs (January 12).

GRADUATE (with suitable training in physiology, biochemistry, pharmacology or chemistry) IN THE DEPARTMENT OF PHARMACOLOGY AND THERAPEUTICS, to assist in research on the effect of drugs on gastric function—The Registrar, The University, Sheffield (January 12).

POLYMER CORPORATION RESEARCH STUDENT (with a good honours degree in chemistry or general science, including chemistry), to register for a higher degree, working on cationic polymerization under the direction of Dr. P. H. Plesch—The Registrar, University College of North Staffordshire, Keele, Staffs (January 12).

READER IN MATHEMATICS at Queen Elizabeth College—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 14).

SENIOR SCIENTIFIC OFFICER (with an honours degree in physiology or with veterinary qualifications and postgraduate research experience in physiology) IN THE PHYSIOLOGY DEPARTMENT, for work concerned with the physiology of temperature regulation—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr, Scotland (January 16).

OFFICIAL FELLOW IN PHILOSOPHY—The Vice-President, Trinity College, Oxford (January 18).

READER or SENIOR LECTURER (highly qualified in statistical theory and widely experienced in the application of statistics to practical problems) IN STATISTICS at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 31).

SENIOR LECTURERS (2) IN PHYSICS at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 31).

SENIOR LECTURER (with a good honours degree in psychology or equivalent) IN PSYCHOLOGY at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 8).

LECTURER (with a research degree in nutrition, biochemistry or chemistry, followed by specialization in nutrition or biochemistry) IN BIOCHEMISTRY AND NUTRITION, at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, February 15).

LECTURER (preferably with interests in the experimental aspects of ecology or taxonomy) IN BOTANY in St. Salvator's College—The Joint Clerk to the University Court, College Gate, St. Andrews (February 18).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN BIOCHEMISTRY, CHEMISTRY, CHEMOTHERAPY, ENGINEERING, METALLURGY, PHARMACOLOGY, PHYSICS, and subjects allied to chemistry or physics—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

TURNER AND NEWALL RESEARCH FELLOW IN ENGINEERING, INORGANIC CHEMISTRY, PHYSICS or an allied subject—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

ASSISTANT CHEMIST, Experimental Officer grade, for analytical work on crops and soils—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting Ref. No. 1052/9.

ASSISTANT EXPERIMENTAL OFFICER (female, with a degree in biological science or equivalent qualifications, and also good secretarial qualifications) TO BE PERSONAL ASSISTANT to the Head of the Physiology Department—The Secretary, National Institute for Research in Dairying (University of Reading), Shinfield, Reading, quoting 56/9.

CHEMIST (aged 20–30, with a second-class honours degree in chemistry or A.R.I.C., and a genuine interest in the technical aspects of colonial development) in the Chemist's Department, Government of Tanganyika, for general and analytical research work in toxicology, food and drugs, and waters, and the supervision and training of African Assistant Chemists and Chemical Assistants—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.97/8/01.

CHEMIST (with a first- or good second-class honours degree in chemistry) IN THE GEOLOGICAL SURVEY DEPARTMENT, Uganda, for the analysis of ores, rocks and minerals, with particular reference to the ores of tungsten, beryl, niobium and tantalum, and analyses of limestones, and to work in close co-operation with the Department's ore-dressing laboratory—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.105/9/06.

HOSPITAL BIOCHEMIST (Senior grade) at Llandough Hospital, Penarth, Glamorgan—The Secretary, United Cardiff Hospitals, Cardiff Royal Infirmary, Newport Road, Cardiff.

PROFESSOR OF CHEMICAL ENGINEERING—The Head, Department of Chemistry, University of Saskatchewan, Saskatoon, Sask., Canada.

RESEARCH WORKER (with some postgraduate experience in research), to take part in a programme of research on the behaviour of normal and malignant cells in tissue culture—The Secretary, University College, Gower Street, London, W.C.1.

SCIENTIFIC OFFICER (honours graduate, preferably with some previous research experience) IN THE BACTERIOLOGY DEPARTMENT, to take part in research on the intestinal flora of the pig—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 56/13.

SENIOR BOTANIST (male, with at least a second-class honours degree in natural science or biological science, and at least eight years postgraduate experience in the fields of botany and plant pathology) IN THE DEPARTMENT OF AGRICULTURE, Uganda, to take charge of the Botany and Pathology Section, and to be responsible for all research and advisory services under these heads—The Director of Recruitment, Colonial Office, London, S.W.1, quoting Ref. BCD. 63/9/06.

TECHNICIAN IN THE GEOLOGY DEPARTMENT—The Secretary, The University, Exeter.

ZOOLOGIST (or otherwise suitably qualified biologist, B.Sc.), to assist in tissue culture work and implantation of tumours in connexion with studies of radiation effects—The Director, M.R.C. Experimental Radiopathology Research Unit, Hammersmith Hospital, Ducane Road, London, W.12.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

National Institute of Agricultural Botany. Farmers' Leaflets. No. 5 (Revised July, 1956): Strains of Sugar Beet, Recommended List. Pp. 4. No. 11 (July, 1956): Varieties of Linseed. Pp. 2. (Cambridge: National Institute of Agricultural Botany, 1956.) [249

Industry and the Technical Colleges: a Review of some Current Problems. (F.B.I. Handbook.) Pp. iii+44. (London: Federation of British Industries, 1956.) 3s. [810

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines, under the Coal Mines Act, 1911, for 1955. North Western Division. By G. Hoyle. Pp. ii+32+6 plates. 2s. 6d. net. Scottish Division. By W. Widdas. Pp. ii+26+4 plates. 2s. 6d. net. Durham Division. By W. Brown. Pp. ii+34+6 plates. 2s. 6d. net. North Eastern Division. By C. W. Scott. Pp. ii+33+6 plates. 2s. 6d. net. (London: H.M. Stationery Office, 1956.) [1710

The Secret Police and You. Pp. ii+16. (London: Campaign for the Limitation of Secret Police Powers, c/o Stanley Mayne, 28 Broadway, S.W.1, 1956.) 9d. [1710

Department of Scientific and Industrial Research: National Physical Laboratory. Notes on Applied Science No. 17: High Voltage Impulse Testing. Pp. iv+10. (London: H.M. Stationery Office, 1956.) 1s. 6d. net. [1710

***Water Research News*, No. 1. Pp. 30. (Redhill: Water Research Association, 1956.)** [1710

Medical Research Council. Careers in Medical Research. Second edition. Pp. 26. (London: Medical Research Council, 1956.) [1710

British Internal Combustion Engine Research Association. Thirteenth Annual Report, 1st April, 1955–31st March, 1956. Pp. 24. (Slough: British Internal Combustion Engine Research Association, 1956.) [1710

National Central Library. 40th Annual Report of the Executive Committee for the year ending 29 February 1956. Pp. 18. (London: National Central Library, 1956.) [1710

Iodine Information. No. 49: Iodine in Rocks and Soils, with Notes on Common Salt and Chilean Nitrate of Soda. Pp. 40. (London: Chilean Iodine Educational Bureau, 1956.) [1710

Thermodynamic Tables and Other Data. Edited by R. W. Haywood. Pp. 23. (Cambridge: At the University Press, 1956.) 2s. 6d. net. [1710

British Museum (Natural History). The Functions of the Natural History Museum. Pp. 10. (London: British Museum (Natural History), 1956.) [1710

Bulletin of the British Museum (Natural History). Zoology. Vol. 4, No. 4: Variation, Relationships and Evolution in the *Packycephala Pectoralis* Superspecies (*Aves*, *Muscicapidae*). By Ian C. J. Galbraith. Pp. 131–222. (London: British Museum (Natural History), 1956.) 24s. [1710

Ministry of Agriculture, Fisheries and Food. Oyster Cultivation in Britain: a Manual of Current Practice. By Dr. H. A. Cole. Pp. 43+43 plates. (London: H.M. Stationery Office, 1956.) 5s. net. [1710

***Spectrovision*. No. 1 (Autumn, 1956). Pp. 8. (Cambridge: Unicam Instruments, Ltd., 1956.)** [1710

***Automation Progress*: The Journal of Automatic Production and Control. Vol. 1, No. 1 (October, 1956). Pp. xxviii+48. Published monthly. Annual subscription, 50s. (London: Leonard Hill Technical Group, 1956.)** [1710

Other Countries

Bechuanaland Protectorate: Geological Survey Department. Annual Report, 1955. Pp. 46. (Lobatsi: Geological Survey, 1956.) 3s. [1710

Marketing of Fruit and Vegetables in Europe. Pp. 328. (Project No. 249 C.) (Paris: European Productivity Agency of the Organization for European Economic Co-operation; London: H.M. Stationery Office, 1956.) 600 francs; 12s.; 2 dollars. [1710

Universidad Nacional del Cuzco. Leyes Geneticas de los Elementos Quimicos: Neuvo Sistema Periodico. Por Oswaldo Baca Mendoza. Pp. 24. (Cuzco, Peru: Universidad Nacional del Cuzco, 1956.) [1710

***Polish Medical History and Science Bulletin*. Vol. 1, No. 1 (July 1956). Pp. 48. (Chicago, Ill.: Polish Medical Alliance, 1956.) 1.50 dollars.** [1710

Republic of Egypt. Ministry of Commerce and Industry: Mineral Resources Department. Geological Survey. Topology, Geology and Iron-Ore Deposits of the District East of Aswan. By M. I. Attia. Pp. xii+262+90 plates. (Cairo: Ministry of Commerce and Industry: Mineral Resources Department, 1955.) P.T. 225. [1710

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 37 (August 1956): America's Children. Pp. 12. (New York: Metropolitan Life Insurance Company, 1956.) [1710

Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac. Vol. 15, Part 3: Coordinates of Venus, 1800–2000. By Paul Herget. Pp. x+217+524. (Washington, D.C.: Government Printing Office, 1956.) 2.50 dollars. [1710

Tokyo Astronomical Observatory. Tokyo Astronomical Bulletin. Second Series. No. 78 (March 5, 1956): Meridian Observation of Right Ascension of Equatorial Stars made with Repsold Transit Instrument. Preliminary Results. No. 9 (July–December 1954). By Konosuke Tuzi. Pp. 763–806. No. 81 (March 20, 1956): Meridian Observation of Right Ascension and Equatorial Stars made with Repsold Transit Instrument. Preliminary Results. No. 10 (January–June 1955). By Konosuke Tuzi. Pp. 817–846. No. 82 (May 20, 1956): Observations of the Contact Times of the Solar Eclipse of June 20, 1955. By M. Utida. Pp. 847–854. No. 83 (June 20, 1956): Instruments and Programmes of the Solar Eclipse Expedition to Ceylon on June 20, 1955. Pp. 855–870. No. 84 (June 20, 1956): Photographic Observations made with the Brashear Astrograph (32). By H. Hiroa and K. Tomita. Pp. 871–874. (Tokyo: Tokyo Astronomical Observatory, 1956.) [1710

Centro Brasileiro de Pesquisas Fisicas. Notas de Fisica. Vol. 2, No. 11: Radiation Field of an Oscillating Dipole—1. By Erasmo Madureira Ferreira. Pp. 20. (Rio de Janeiro: Centro Brasileiro de Pesquisas Fisicas, 1955.) [1710

Somaliland Protectorate. Annual Report of Geological Survey, April, 1955–March, 1956. Pp. iv+31. (Hargeisa: Chief Secretary to the Government, Somaliland Protectorate; London: Crown Agents for Oversea Governments and Administrations, 1956.) 8hs. 2/50. [1710

Memoirs of the India Meteorological Department. Vol. 30, Part 4: A Study of Fifty Years' Rainfall of Visakhapatnam. By K. P. Ramakrishnan and J. Narayanan. Pp. ii+155–186+3 plates. (Delhi: Manager of Publications, 1955.) Rs. 3 As. 6; 5s. 6d. [1710

Southern Rhodesia. Report of the Trustees and Director of the National Museums of Southern Rhodesia, for the year ended 31st December, 1955. Pp. 22. (Bulawayo: National Museums of Southern Rhodesia, 1956.) [1710

United States Department of the Interior: Geological Survey. Professional Paper 258: Geology and Petrology of the San Juan Region, Southwestern Colorado. By E. S. Larsen, Jr., and Whitman Cross. Pp. xiv+303+4 plates. (Washington, D.C.: Government Printing Office, 1956.) n.p. [1710

Annals of the Tokyo Astronomical Observatory. Second Series. Vol. 4, No. 3: Tables for the Approximate Special Perturbations by means of the Variation of Parameters. By Tadao Takenouchi. A Photoelectric Study of the Atmospheric Extinction at Tokyo Astronomical Observatory. By Masatoshi Kitamura and Tsuyoshi Nakamura. Pp. ii+157–188. (Mitaka, Tokyo: Tokyo Astronomical Observatory, 1956.) [1710

***Zoologica*: Original-Abhandlungen aus dem Gesamtgebiet der Zoologie. Heft 106: Oxyuroid Parasites of Arthropoda: a Monographic Study, 1: Thelastomatidae. 2: Oxyuridae. By M. A. Basir. Pp. iv+80+13 plates. (Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller), 1956.) n.p.** [1710

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